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The Trusted Integrator for Sustainable Solutions

**SAMPLING AND ANALYSIS QUALITY ASSURANCE PROJECT PLAN
PRE-REMEDIAL SITE ASSESSMENT ACTIVITIES
LAUNDRY ESPINOSA
DORADO, PUERTO RICO**

Prepared for:

U.S. Environmental Protection Agency
Region 2
New York, New York 10007

Prepared by:

Weston Solutions, Inc.
Edison, New Jersey 08837

EPA Contract No. EP-S5-06-04

April 2011




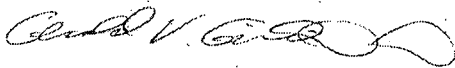
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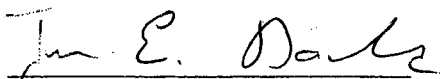
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1.0 INTRODUCTION

Under the Region V Superfund Technical Assessment and Response Team III (START III) contract, the U.S. Environmental Protection Agency (EPA) has tasked Weston Solutions, Inc. (WESTON®) to conduct a Preliminary Assessment/Site Inspection (PA/SI) at the Laundry Espinosa site. Presented herein is the Sampling and Analysis Quality Assurance Project Plan (SAQAPP) for the pre-remedial field activities to be conducted as part of the PA/SI. The site-specific SAQAPP has been developed at the request of EPA in accordance with the EPA Region 2 CERCLA Quality Assurance Manual (October 1989), WESTON's Quality Assurance Project Plan (QAPP) for the Region V START III contract (June 2006), and additional documents as cited.

The sampling strategy presented in this plan emphasizes the collection of samples required to evaluate certain exposure pathways of interest to the CERCLA Program, in this case the groundwater pathway. The sampling plan includes the following sections: Site Reconnaissance (2.0), Sampling Event and Sampling Procedures (3.0), Quality Assurance/Quality Control (4.0), and Field Changes and Corrective Actions (5.0). Additional quality assurance specifications can be found in the Region V START III QAPP (June 2006), which is included by reference, or in other cited documents.

1.1 Site Description

The Laundry Espinosa site is a small, retail dry cleaner located in a strip mall in a commercial area in Dorado, Puerto Rico. The facility is built on a hillside, with topography sloping to the south toward residential properties directly downgradient. The site is bound to the north by Route 2, which is directly connected to the parking area in front of Laundry Espinosa. The ground surface along the front of the building is paved with asphalt. Runoff on the site flows from Route 2 thru the driveway and into the back of the facility via a hole in the concrete. The south (back) and east sides of the facility are vegetated and the west side of the property is bound by another similar strip mall facility. The south side of the facility houses a small storage shed. There is a small drainage trench that runs east along the back of the facility and turns south along the residential driveway. The small residential properties to the south of Laundry Espinosa separate the site from a muffler distribution facility. A Site Location Map is presented as Figure 1.

1.2 Previous Work at the Site

Analytical results of aqueous samples collected by WESTON in July 2008 from the Maguayo public well system confirmed the presence of tetrachloroethylene (PCE) and trichloroethylene (TCE) at concentrations above their respective Hazard Ranking System (HRS) Level I benchmarks. Therefore, pre-Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) screening activities at this facility were conducted under EPA's Maguayo Site Discovery in June 2008 and August 2009. When WESTON personnel first observed the Laundry Espinosa facility it appeared clean and well-maintained. However, Laundry Espinosa had been operating at that location for 30 years, and was using Exol, an ethanol-based cleaning solution, at the time of the visit. Based on possible historical use of PCE as a cleaning solvent (as is common in the dry cleaning industry) and the length of time that dry cleaning has been conducted at the site (i.e. 30 years), Laundry Espinosa is recommended for further assessment under CERCLA.

1.3 Schedule

The tentative schedule for the Laundry Espinisa sampling event is:

<u>Activity</u>	<u>Proposed Start Date</u>	<u>End Date</u>
Soil and Groundwater Sampling	To be determined (TBD)	TBD
Analysis & Data Validation	TBD	TBD
Data Receipt	TBD	TBD
Draft Report	TBD	TBD

The following personnel are tentatively scheduled to work on this project:

<u>Personnel</u>	<u>Responsibility</u>
TBD	Field Coordinator, Quality Assurance/Quality Control (QA/QC), Site Health and Safety Officer (SHSO), Sampler
TBD	Site Geologist, Global Positioning System (GPS) Data Collection, Sampler
TBD	Sampler, Field Screening Analysis
TBD	Sample Management Officer (SMO)

2.0 SITE RECONNAISSANCE

On March 21, 2011, WESTON conducted an on-site reconnaissance of the Laundry Espinosa site. The owner of Laundry Espinosa indicated that he does not own the property and that he could not provide the owner's contact information. WESTON was not granted access into the facility but was able to make observations around the outside of the building. There were no visible signs of staining around the outside of the facility, however, there was an area of stressed vegetation behind the building. All exterior areas of the site were noted to be accessible for sampling with Geoprobe™.

3.0 SAMPLING EVENT AND SAMPLING PROCEDURES

This section outlines overall sample management and control procedures to be implemented by WESTON personnel during field activities. Standard analytical methods, preservation, holding times, and sample containers are summarized in Table 1.

3.1 Sample Tracking System

3.1.1 Sample Identification System

Each sample collected by WESTON will be designated by a site-specific project code. The code for the Laundry Espinosa site is **1312**, which is the numeric code (i.e., task number) that identifies this project. The media type will follow the code. A hyphen will separate the site code and media type.

Specific media types are as follows:

S – Surface Soil
GW – Groundwater
TB – Trip Blank

SS – Subsurface Soil
RIN – Rinsate Blank

After the media type, sequential sample numbers will be listed; sample numbers will be identified in the field. A duplicate sample will be identified in the same manner as other samples and will be distinguished and documented in the field logbook.

3.1.2 Sample Bottles

Sample bottles will be obtained from qualified vendors and will meet all guidelines specified in OSWER Directive 9240.0-05A, Specifications and Guidance for Obtaining Contaminant-Free Sample Containers (December 1992).

3.1.3 Sample Packaging and Shipping

Samples will be packaged and shipped according to the EPA *Contract Laboratory Program (CLP) Guidance for Field Samplers* (May 2010). Traffic reports (TR)/chain-of-custody (COC) forms, sample labels, custody seals, and other sample documents will be completed as specified in the above-referenced manual and OSWER Directive 9200.1-103, Inclusion of Scribe into the Role of Tracking Superfund Sampling Data (November 2010). Documentation examples are included in Appendix A. All entries will be made in permanent ink. If errors are made when completing any of these forms, the error will be crossed out with a single line, initialed, and dated by the sampler. Each environmental sample will be properly identified and sealed in a polyethylene bag. The bag shall then be placed in a plastic cooler which has also been lined with a large polyethylene bag. Samples will be packed with sufficient ice (sealed in polyethylene bags) to cool the samples to 4°C.

Sufficient non-combustible, adsorbent cushioning material shall be placed in the cooler so as to minimize the possibility of container breakage. The large plastic bag shall then be sealed and the container closed. Custody seals and strapping tape shall then be affixed to the outer packaging. All samples will either be hand-delivered or shipped via common carrier to the laboratory within 24 hours of collection. Sample shipment will conform to WESTON's Manual of Procedures for Shipping & Transporting Dangerous Goods, Section 1, subsections 1.0, 2.0, and 2.1 dated September 2005 [Appendix B] and EPA regulations (40 CFR 136), which both indicate that preserved environmental samples can be shipped as non-hazardous materials. Information relating to the shipment of samples, including the airbill number, sample quantity, and sample types, will be reported to the EPA Sample Management Office on the day of or morning after shipment.

3.1.4 Sample Documentation

The sampling team or individual performing the sampling activity will maintain a field logbook. The bound, numbered, and paginated logbook shall be filled out at the location of sample collection immediately after sampling. The logbook shall contain sampling information, including: sample number, sample collection time, sample location, sample descriptions, sampling methods, weather conditions, field measurements, name of sampler, site-specific observations, and any deviations from protocol. All entries will be entered legibly in permanent ink. If errors are made when completing this logbook, the error will be crossed out with a single line, initialed, and dated by the sampling team. WESTON will use GPS to record sample and other site feature locations electronically, and will include a description of the GPS data collection and site identifiers in the field logbook.

3.2 Sampling Program

WESTON will collect surface soil, subsurface soil, and groundwater samples from four boreholes advanced along the north and south sides of the site building. One additional borehole, which will serve as a background location, will be advanced on the periphery of the property, believed to be unaffected by site activities. These soil and groundwater samples will be obtained using Geoprobe™ direct-push method. The soil and groundwater samples will be collected for waste source characterization and to document an observed release to groundwater. The samples will be analyzed for Target Compound List (TCL) volatile organic compounds (VOCs) only. Proposed sampling locations, including the duplicate samples, are presented in Figure 2.

A total of five boreholes will be advanced using direct-push technology to a maximum depth of 50 feet below ground surface (bgs). WESTON will perform field screening via headspace readings with a photoionization detector (PID) to provide quick detection of VOCs throughout the soil column. WESTON will evaluate the results of the headspace screening investigation to determine the locations of possible contaminated soil source areas. Soil samples for PID analysis will be retrieved at 5-foot intervals in each borehole, beginning with the 0- to 2-foot interval (i.e., 0'-2', 5'-7', 10'-12', etc.). The sample fraction for PID analysis will be placed into a sealed and labeled plastic bag and allowed to come to equilibrium with room temperature for 15 minutes. This fraction will consist of the bottom 3 inches of the 2-foot interval, collected directly from the sample liner with a dedicated, disposable plastic scoop. After collection of this screening fraction, each sample liner will be capped and kept on ice for confirmatory CLP sampling (described below). After 15 minutes, the PID

readings from the bag's headspace will be recorded. WESTON will evaluate the results of the headspace screening investigation to determine the locations of possible contaminated soil source areas. If groundwater is encountered at a depth above 50 feet, a soil sample will be collected from the 2-foot interval immediately above the water table, and a CLP groundwater sample will be collected.

Confirmatory CLP soil samples will be collected from possible contaminated soil source areas identified during the PID investigation. Confirmatory CLP samples will be collected from: the shallowest interval in which detectable concentrations of VOCs are indicated; the interval in which the field screening indicates the highest concentration of VOCs for that particular soil column; and the deepest interval from which detectable concentrations of VOCs are indicated. If field screening indicates no elevated VOC readings, confirmatory CLP samples will be collected from the surface, from the approximate midpoint of the borehole, and from just above refusal or the water table. The CLP soil and groundwater samples will be analyzed for TCL VOCs only.

For QA/QC, one trip blank sample will be collected on each day during which environmental aqueous samples are collected. One rinsate blank sample will be collected from the coring device (i.e., Geoprobe™ cutting shoe) in conjunction with the soil sampling. Region 2 does not require matrix spike/matrix spike duplicate (MS/MSD) analyses for TCL VOC analyses.

Soil samples will be collected using 5-gram En Core™ dedicated sampling devices. Direct-push groundwater samples will be collected using dedicated, disposable 20-mL Mini-bailers. Borehole locations will be recorded using GPS technology in accordance with EPA Region 2 Standard Operating Procedures [Appendix C]. Site-specific sample analyses, bottle types, and preservatives are presented in Table 1. A description of proposed site-specific samples, including the rationale for the collection of each sample, is presented in Table 2. Table 3 contains a list of the number of bottles for each sample, analyses to be performed, preservation methods, and descriptions. Additional samples may be collected if deemed necessary while in the field. Samples will be designated for analysis of TCL VOCs via implementation of the Field and Analytical Services Teaming Advisory Committee (FASTAC) analytical services strategy, in accordance with SOP No. HW-32: Standard Operating Procedure for Implementing the National Strategy for Procuring Analytical Services for All OSWER Programs, Revision 7 (EPA Region 2, August 2009). The Region 2 FASTAC strategy requires coordination of all analytical services through the Regional Sample Control Coordinator (RSCC).

The following laboratories will provide the following analyses:

<u>Lab Name/Location</u>	<u>Sample Type</u>	<u>Parameters</u>
Organic CLP Lab - TBD ¹	Soil and Aqueous	TCL VOCs (low-medium concentration) 7-day turnaround to EPA
1) TBD - To be determined		

Listed below are standard operating procedures which will be adhered to during field sampling activities conducted by WESTON.

3.2.1 Surface and Subsurface Soil Sampling

The following procedures apply to the collection of surface and subsurface soil samples from intervals identified for CLP analysis during the PID headspace screening, using a direct-push sampling device:

- 1) Wear personal protective equipment as specified in the Health and Safety Plan. Samplers shall don new outer gloves prior to sampling at each location and at each depth.
- 2) Retrieve soil samples from the specified intervals in a manner consistent with Section 14.3.2 of the EPA Region 2: Division of Environmental Science & Assessment (DESA) SOPs for Field Activities (excerpts) dated December 2006 [Appendix D] and Sections 4.4 and 4.5 of the EPA Region 4: Science and Ecosystem Support Division (SESD) Operating Procedure for Soil Sampling (excerpts) dated November 2007 [Appendix E]. Samples will be collected into 5-foot acetate sample liners, which will be marked appropriately upon retrieval.
- 3) Collect the sample fraction for PID analysis every 5 feet beginning with the 0- to 2-foot interval (i.e., 0'-2', 5'-7', 10'-12', etc.) into a sealed plastic bag, label the bag, and allow it to come to equilibrium for 15 minutes. This fraction will consist of the bottom 3 inches of the specified interval (e.g., 21 to 24 inches), collected directly from the sample liner with a dedicated, disposable plastic scoop.
- 4) Immediately upon collection of the PID fraction, seal the remaining soil as is within the sample liner and place the liner in a container maintained at 4°C.
- 5) After 15 minutes, collect the PID readings from the bag's headspace, and record the results in the field logbook. Upon review of the PID results for each borehole, certain samples will be chosen for laboratory analysis. The remaining steps apply to those samples. Soil not chosen for laboratory analysis will be placed in a drum for off-site disposal.
- 6) Cut the sample liner open and immediately collect the VOC sample fraction from the remaining bottom 3 inches (e.g., 18- to 21-inch interval) using En CoreJ dedicated sampling devices, as described in American Society for Testing and Materials (ASTM) Standard Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil For Volatile Organic Analysis, dated April 2004 [Appendix F].
- 7) Place samples in cooler and chill with ice. Samples will be hand-delivered or shipped within 24 hours of collection to the designated laboratories.
- 8) Fill out field logbook, custody seals, sample labels, and TR/COC forms.

3.2.2 Groundwater Sampling (Direct-push)

If groundwater is encountered during the direct-push sampling activities, groundwater sampling will be conducted in a manner consistent with current EPA guidelines [Section 6.2.4 of the EPA Region 2: DESA SOPs for Field Activities (excerpts) dated December 2006 (Appendix D) and Section 7.11 of SOP 2050 (Appendix G)]. In order to mitigate the effects of installation (i.e., turbidity), the temporary wells will be purged using a peristaltic pump. VOC sample fractions will be collected using a 20-mL well Mini-bailer to avoid aeration of the groundwater and disturbance of the sediments/particulate matter within the well bore during sampling.

The following procedures apply to the collection of grab groundwater samples from the Geoprobe™:

- 1) Wear personal protective equipment as specified in the Health and Safety Plan. Samplers shall don new outer sampling gloves prior to sampling at each location.
- 2) Purge the temporary well according to Section 6.2.4 of the EPA Region 2: DESA SOPs for Field Activities (excerpts) dated December 2006 [Appendix D].
- 3) Obtain grab groundwater samples in accordance with the procedures in Section 7.11 of the Geoprobe SOP #2050 [Appendix G].
- 4) Collect the VOC sample fraction directly from the 20-mL well Mini-bailer into pre-preserved glass vials to prevent degassing of the water. (See Item 4, below, for preservation procedures.) During sample collection, the containers will be held so the discharge causes minimal internal disturbance.
- 5) Preserve the VOC fraction as follows:
 - a) VOCs - Determine the amount of 1:1 HCl preservative required to adjust the pH of the sample to less than 2 in an extra 40-mL glass vial. If effervescence occurs when the bottle is tapped, volatile samples will be submitted without preservative and noted as such on the respective Traffic Report. Add the determined volume of acid to the empty 40-mL glass vials prior to sampling. Fill each container with sample to just overflowing so that no air bubbles are trapped inside. This procedure will be repeated at each new sampling station.
- 6) Place samples in cooler and chill with ice. Samples will be shipped within 24 hours of collection to the designated laboratory(ies).
- 7) Measure the depth to groundwater; record observation in field logbook.
- 8) Fill out field logbook, sample labels, custody seals, and COC/TR forms.

3.3 Decontamination

All non-disposable equipment involved in soil and groundwater sampling activities will be decontaminated prior to and subsequent to sampling. The following decontamination procedures for field sampling equipment have the concurrence of EPA Region 2 Monitoring and Assessment Branch (formerly the Monitoring Management Branch), according to the NJDEP Field Sampling Procedures Manual (August 2005) where the procedures are published. Therefore, the procedures are considered to be applicable throughout Region 2. All decontamination fluids will be containerized and shipped off site for proper disposal. Decontamination of Geoprobe™ cutting shoes will be conducted as follows:

- 1) Alconox detergent and tap water scrub to remove visual contamination,
- 2) Generous tap water rinse,
- 3) Distilled and deionized (ASTM Type II) steam cleaning, and
- 4) Air dry

Decontamination will be carried out over a container. The material generated by decontamination will be placed in drums and stored on the site until receipt of the analytical results. The drums will be stored in a locked, temporary storage shed or container until transferred off-site for proper disposal.

En Core™ dedicated sampling devices and dedicated, disposable 20-mL Mini-bailers will be used to collect the laboratory samples. Dedicated equipment does not require decontamination.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

This section details the QA/QC requirements for field activities performed during the sampling effort.

4.1 Field Instrument Calibration and Preventive Maintenance

The sampling team is responsible for assuring that a master calibration/maintenance log will be brought into the field and maintained for each measuring device. Each log will include at a minimum, where applicable:

- name of device and/or instrument calibrated
- device/instrument serial and/or ID number
- frequency of calibration
- date of calibration
- results of calibration
- name of person performing the calibration
- identification of the calibrant (PID, FID, pH meter)

Equipment to be used each day shall be calibrated prior to the commencement of daily activities.

4.2 QA/QC Sample Collection

This section describes the QA/QC samples that will be collected by the WESTON field team as part of the sampling effort. A summary by sample number for analysis, bottle type, and preservation is presented in Table 3.

4.2.1 Trip Blanks

Trip blanks will be collected for events involving aqueous sampling for volatile organic parameters. A trip blank is an aliquot of demonstrated analyte-free deionized (DI) water which is prepared in the field prior to the initiation of field work and sealed in 40-mL glass vials with Teflon-lined septum caps. Trip blanks are collected at a frequency of one per day of aqueous VOC sampling. Analytical results of the trip blank samples are utilized during sample data validation to determine if any cross contamination has occurred between samples during shipment/storage, or if on-site atmospheric contaminants are seeping into the sample vials. These sealed bottles will be placed in a plastic cooler and will accompany field personnel to the sampling locations.

Trip blanks will be collected in accordance with the procedures listed below:

- 1) Pour DI water into an extra vial. Determine the amount of 1:1 HCl required to lower sample pH to less than 2, verifying with broad range pH paper. Add the predetermined volume of HCl to the three sample vials.

- 2) Proceed to fill the three vials with DI water just to overflowing and seal so that no air bubbles are trapped inside. Place in sample cooler. After the sampling event is completed, the trip blank sample will be packaged and hand-delivered or shipped within 24 hours of collection, along with the environmental samples, to the designated laboratory.
- 3) Complete sample labels, custody seals, and chain of custody forms. Record in field logbook.

4.2.2 Field Rinsate Blanks

A field rinsate blank will consist of DI, demonstrated analyte-free water that has been poured over dedicated and decontaminated sampling equipment. The field rinsate blank analytical results will be utilized in the evaluation of potential cross contamination resulting from inadequate decontamination. The frequency of field rinsate blank collection is one blank per decontamination event per type of equipment, not to exceed one per day. For the purposes of sampling associated with pre-remedial field activities, field rinsate blank collection will not exceed a total of four samples. Blanks will be collected for all parameters of interest (excluding TOC and grain size parameters) and shipped with the samples collected the same day.

Field rinsate blanks will be collected in accordance with the procedure listed below:

- 1) Decontaminate sampling equipment using the procedure specified in Section 3.3 of this plan.
- 2) Pour DI water over the sampling device and collect the rinsate in the appropriate sample containers.
- 3) Preserve samples as specified in Table 3 of this plan.
- 4) Complete sample labels, custody seals, and chain of custody forms. Record in field logbook.

4.2.3 Deionized Water Blanks

The distilled DI water utilized for the trip and field blanks will be certified as such. A copy of this certificate will be kept on site and another in the site-specific project file. The criteria to be demonstrated as analyte-free will be consistent with that specified in the EPA Region 2 CERCLA Quality Assurance Manual (October 1989), and is as follows:

Purgeable organics < 10 ppb
Semi-volatile organics < CRQL
Pesticides/PCBs < CRQL
Inorganics < CRDL

where the CRQLs and CRDLs are represented by the Contract Required Quantitation Limits in the most recent CLP Statements of Work. For specific common laboratory contaminants such as methylene chloride, acetone, toluene, 2-butanone and phthalates, the allowable limits are three times the respective CRQLs.

4.2.4 Duplicate Samples

Duplicate samples will be sent for laboratory analysis to evaluate the ability of reproducing the sampling methods. At a minimum, a rate of one duplicate sample per 20 samples, or one duplicate sample per batch of less than 20 samples, will be obtained. Region 2 does not require MS/MSD analyses for TCL VOC analyses.

4.2.5 Split Samples

Splitting of samples will be conducted upon request when the site owner/operator or potentially responsible party (PRP) wishes to ensure that sample results generated by WESTON are accurate. WESTON is not responsible for supplying the necessary amount of sample containers for the site owner/operator. It is not necessary to assess the site owner/operator laboratory performance or laboratory methods used, although the methods should be of equivalent performance. The site owner/operator will be informed that split samples are to be analyzed at their own expense.

4.2.6 Background Samples

In order to accurately assess any potential contamination on the site, background samples for each pathway matrix of concern will be collected. The analysis of each sample will be equal to those specified for the environmental samples. For the purposes of site assessment projects, background samples will be collected from locations not suspected to be affected by site activities; selection of the background sample locations will be based on field observation, available site information, and the professional judgement of the sampling team.

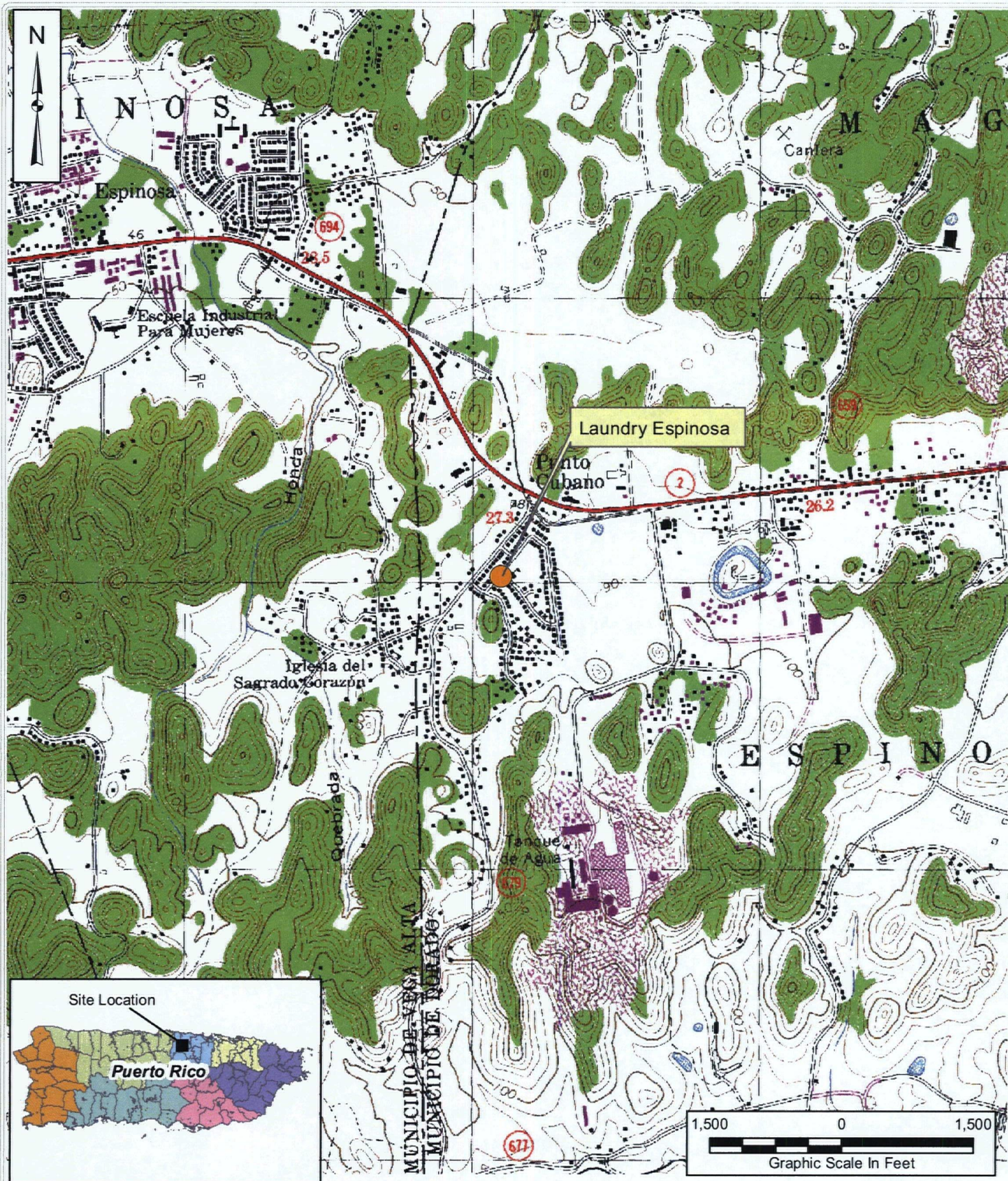
4.2.7 Data Validation


Analytical results obtained through the CLP and/or the EPA Division of Environmental Science and Assessment (DESA) will be validated in accordance with the most current EPA Region 2 data validation guidelines under a separate EPA contract.

5.0 FIELD CHANGES AND CORRECTIVE ACTIONS

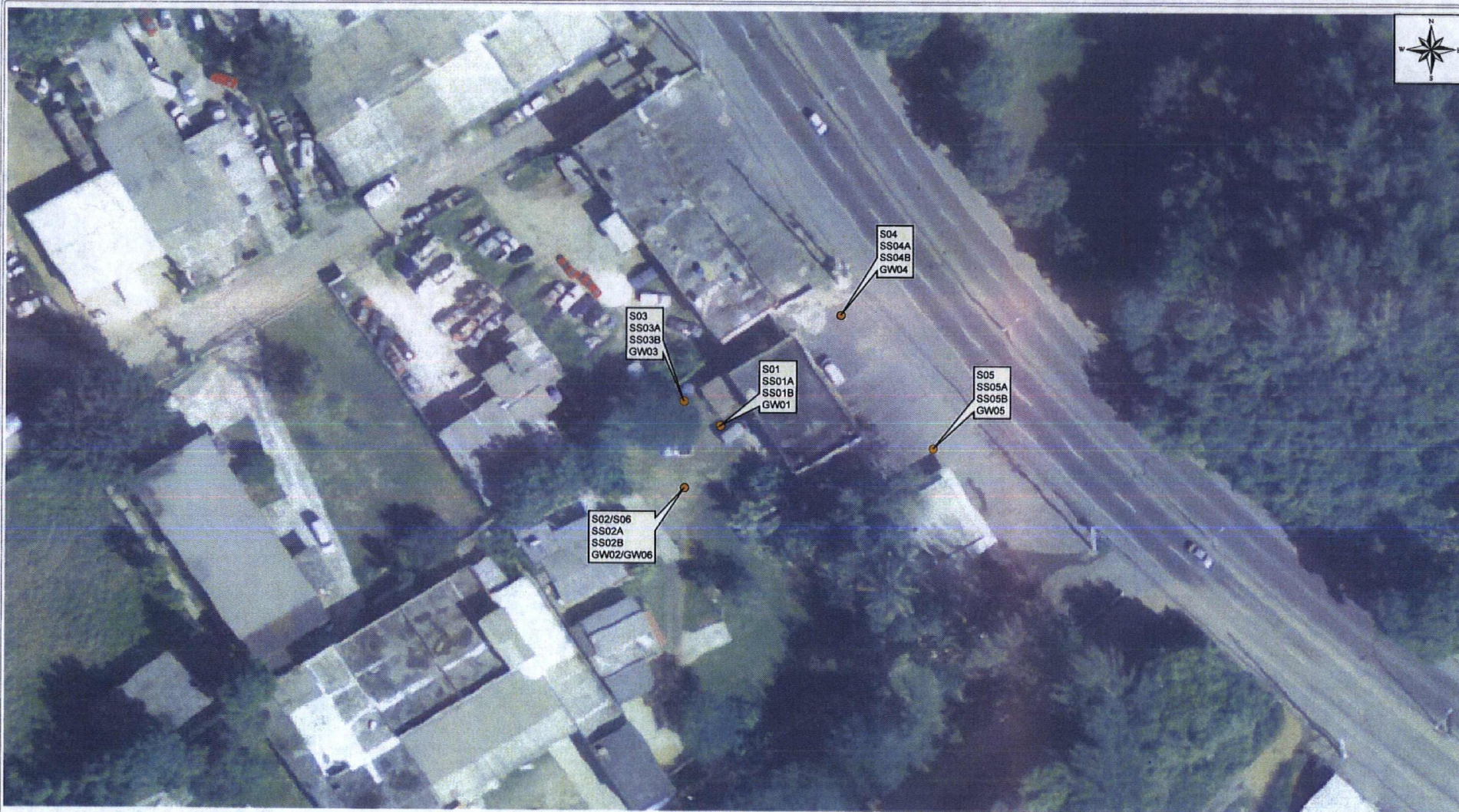
The WESTON Project Manager (PM) or his/her designee may be required to modify generic site procedures to accommodate site-specific needs or unforeseeable events. In the event it becomes necessary to modify a procedure, the PM will notify the EPA Region 2 WAM. Deviations from the Field Sampling Plan will be documented in the field logbook and signed by the initiator and the PM.

FIGURES



LEGEND:	
	Approximate Site Location
SOURCE:	7.5 Minute Series Topographic Quadrangle: Vega Alta, PR.
PROJECT:	Laundry Espinosa
CLIENT NAME:	EPA

TITLE:	Site Location Map Laundry Espinosa Dorado, PR
DATE:	April 2011
FIGURE #:	1

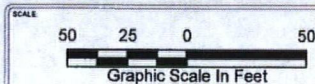


DRAFT MAP - For Internal Use Only

Legend

● Proposed Sample Location

NOTE: All sample location ID's are preceded by 1312-



PROJECT
PRIDCO Lot Nos: L-107-2-64-16/18/19

CLIENT NAME
EPA

TITLE
Proposed Boring Location Map
Laundry Espinosa
Dorado, PR

WESTON
SOLUTIONS

DATE
4/13/2011

FIGURE #
2

TABLES

TABLE 1
CLP ROUTINE ANALYTICAL SERVICES
LAUNDRY ESPINOSA

Sample Type	Number of Samples	Matrix	Sampling Device	Sample Container ⁽¹⁾	Sample Preservation	Technical Holding Time ⁽²⁾	CLP Laboratory Analyses ⁽³⁾
Surface Soil	6 (including one duplicate)	Soil (Low/Medium Concentration)	Direct-push equipment, EnCore sampler	Three 5-gram En Core™ dedicated sampling devices One 4-oz. glass jar	Cool to 4°C	48 hours to preserve; 7 days to analyze (from verified time of sample receipt)	TCL VOCs CLP SOW SOM01.2 % Moisture
Subsurface Soil	10						
Groundwater	6 (including one duplicate)	Aqueous (Low/Medium Concentration)	Teflon-lined mini bailer	Three 40-mL vials w/ Teflon septum caps	HCl to pH<2 Cool to 4°C	14 days to analyze	TCL VOCs CLP SOW SOM01.2
Rinsate Blanks	1		N/A				
Trip Blanks	1		N/A				

⁽¹⁾ = Sample containers are certified clean by the manufacturer.

⁽²⁾ = Technical holding times are calculated from the date of sample collection.

⁽³⁾ = Contract Laboratory Program (CLP) Statement of Work (SOW) for Organic Analysis SOM01.2 (low/medium concentration), or most current revision.

TABLE 2
SAMPLE DESCRIPTIONS/RATIONALE
LAUNDRY ESPINOSA

SAMPLE NUMBER	DESCRIPTION/RATIONALE
1312-GW01	Groundwater sample from a Geoprobe™ borehole advanced on the back (south) side of the building, for evaluation of observed release.
1312-S01	Surface soil sample from a Geoprobe™ borehole advanced on the back (south) side of the building, for waste source characterization.
1312-SS01A	Subsurface soil sample from a Geoprobe™ borehole advanced on the back (south) side of the building, for waste source characterization.
1312-SS01B	Subsurface soil sample from a Geoprobe™ borehole advanced on the back (south) side of the building, for waste source characterization.
1312-GW02	Groundwater sample from a Geoprobe™ borehole advanced on the south side of the property, for evaluation of observed release.
1312-GW06	Duplicate of 1312-GW02 for quality assurance/quality control (QA/QC purposes).
1312-S02	Surface soil sample from a Geoprobe™ borehole advanced on the south side of the property in area of bare soil, for waste source characterization.
1312-S06	Duplicate of 1312-S02 for QA/QC purposes.
1312-SS02A	Subsurface soil sample from a Geoprobe™ borehole advanced on the south side of the property in area of bare soil, for waste source characterization.
1312-SS02B	Subsurface soil sample from a Geoprobe™ borehole advanced on the south side of the property in area of bare soil, for waste source characterization.
1312-GW03	Groundwater sample from a Geoprobe™ borehole advanced on the west side of the property near the storage shed, for evaluation of observed release.
1312-S03	Surface soil sample from a Geoprobe™ borehole advanced on the west side of the property near the storage shed, for waste source characterization.
1312-SS03A	Subsurface soil sample from a Geoprobe™ borehole advanced on the west side of the property near the storage shed, for waste source characterization.
1312-SS03B	Subsurface soil sample from a Geoprobe™ borehole advanced on the west side of the property near the storage shed, for waste source characterization.
1312-GW04	Groundwater sample from a Geoprobe™ borehole advanced on the north side of the building in the parking area, for evaluation of observed release.
1312-S04	Surface soil sample from a Geoprobe™ borehole advanced on the north side of the building in the parking area, for waste source characterization.
1312-SS04A	Subsurface soil sample from a Geoprobe™ borehole advanced on the north side of the building in the parking area, for waste source characterization.
1312-SS04B	Subsurface soil sample from a Geoprobe™ borehole on the north side of the building in the parking area, for waste source characterization.
1312-GW05	Background groundwater sample from an area believed to be unaffected by site activities.
1312-S05	Background surface soil sample from an area believed to be unaffected by site activities.
1312-SS05A	Background subsurface soil sample from an area believed to be unaffected by site activities.
1312-SS05B	Background subsurface soil sample from an area believed to be unaffected by site activities.
1312-RIN01	Rinsate blank (Geoprobe™ cutting shoe) for QA/QC purposes.
1312-TB01	Trip Blank for QA/QC purposes.

Temperature Blanks will be placed in each cooler with samples shipped to the laboratory.
Additional trip blanks may be added should sampling continue beyond one day.
Additional source / waste samples may be added or deleted depending on further investigation.

TABLE 3.
SAMPLE ANALYSES, BOTTLE TYPES, AND PRESERVATIVES
LAUNDRY ESPINOSA

SAMPLE NUMBER	SAMPLE BOTTLES	ANALYSIS	PRESERVATION
1312-GW01	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C
1312-S01	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS01A	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS01B	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-GW02	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C
1312-GW06 (Duplicate)	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C
1312-S02	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-S06 (Duplicate)	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS02A	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS02B	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-GW03	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C
1312-S03	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS03A	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS03B	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-GW04	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C
1312-S04	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS04A	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS04B	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-GW05	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C
1312-S05	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS05A	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-SS05B	3 5-grams En Core™ 1 4-oz. glass jar	TCL VOCs percent moisture	Ice - Cool to 4°C
1312-RIN01	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C
1312-TB01	3 40-mL glass vials	TCL VOCs	HCl, pH<2, Ice, Cool to 4°C

APPENDIX A
DOCUMENTATION EXAMPLES

Sample Labels – Example

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: TCL VOCs
Preservation: Ice Only

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: TCL VOCs
Preservation: Ice Only

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: TCL VOCs
Preservation: Ice Only

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: % Moisture
Preservation: Ice Only

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: TCL SVOCs/Aroclors
Preservation: Ice Only

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: TCL SVOCs/Aroclors
Preservation: Ice Only

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: TAL Inorganics + Hg
Preservation: Ice Only

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: Grain Size
Preservation: None Required

Sample No.: NC-SD01A
CLP No.: B5DJ5 Case No.: 38236
Date/Time:
Analysis: TOC
Preservation: None Required

Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: TCL VOCs
Preservation: Ice Only

Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: TCL VOCs
Preservation: Ice Only

Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: TCL VOCs
Preservation: Ice Only

Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: % Moisture
Preservation: Ice Only

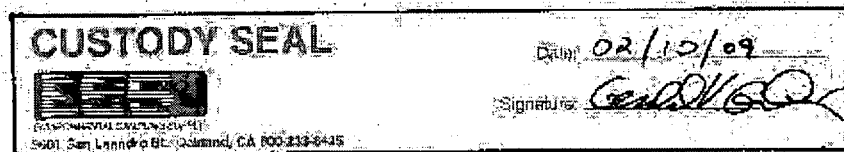
Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: TCL SVOCs/Aroclors
Preservation: Ice Only

Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: TAL Inorganics + Hg
Preservation: Ice Only

Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: Grain Size
Preservation: None Required

Sample No.: NC-SD01B
CLP No.: B5DJ6 Case No.: 38236
Date/Time:
Analysis: TOC
Preservation: None Required

Custody Seal - Example



EPA USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

Case No: 40095

DAS No:

R

Region: 2	Date Shipped: 10-05-06	Chain of Custody Record Relinquished By (Date / Time) Received By (Date / Time) 1 <i>R. Snyder</i> 5/6/10/1800 <i>FedEx</i> 5/6/10/1800 2 3 4
Project Code:	Carrier Name: FedEx	
Account Code:	Airbill: 8701 0099 4720	
CERCLIS ID: NJN000206345	Shipped to: A4 Scientific, Inc. 1544 Sawdust Road Suite 505 The Woodlands TX 77380 (281) 292-5277	
Spill ID: A238		
Site Name/State: Byram Township TCE Regional Groundwat		
Project Leader: Scott Snyder		
Action: Integrated Assessment (IA)		
Sampling Co: WESTON - START 5		

ORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No/ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME		INORGANIC SAMPLE No.	QC Type
B7GF8	Ground Water/ Scott Snyder	M/G	VOC (aq) (7)	(HCL) (3)	BYR-GW109	S: 10-05-06	15:20		-
B7GG0	Ground Water/ Scott Snyder	M/G	VOC (aq) (7)	(HCL) (3)	BYR-GW111	S: 10-05-06	11:40		-
B7GG1	Ground Water/ Scott Snyder	M/G	VOC (aq) (7)	(HCL) (3)	BYR-GW112	S: 10-05-06	11:45		Field Duplicate
B7GK0	Field QC/ Scott Snyder	L/G	VOC (aq) (7)	(HCL) (3)	BYR-RIN102	S: 10-05-06	13:10		Rinsate
B7H60	Field QC/ Scott Snyder	M/G	VOC (aq) (7)	(HCL) (3)	BYR-TB108	S: 10-05-06	9:25		Trip Blank

Shipment for Case Complete? N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): <i>M. Gentry</i>	Chain of Custody Seal Number:
Analysis Key: VOC (aq) = TCL VOCs (aqueous)	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Shipment Iced? _____

TR Number: 2-344931618-050610-0010

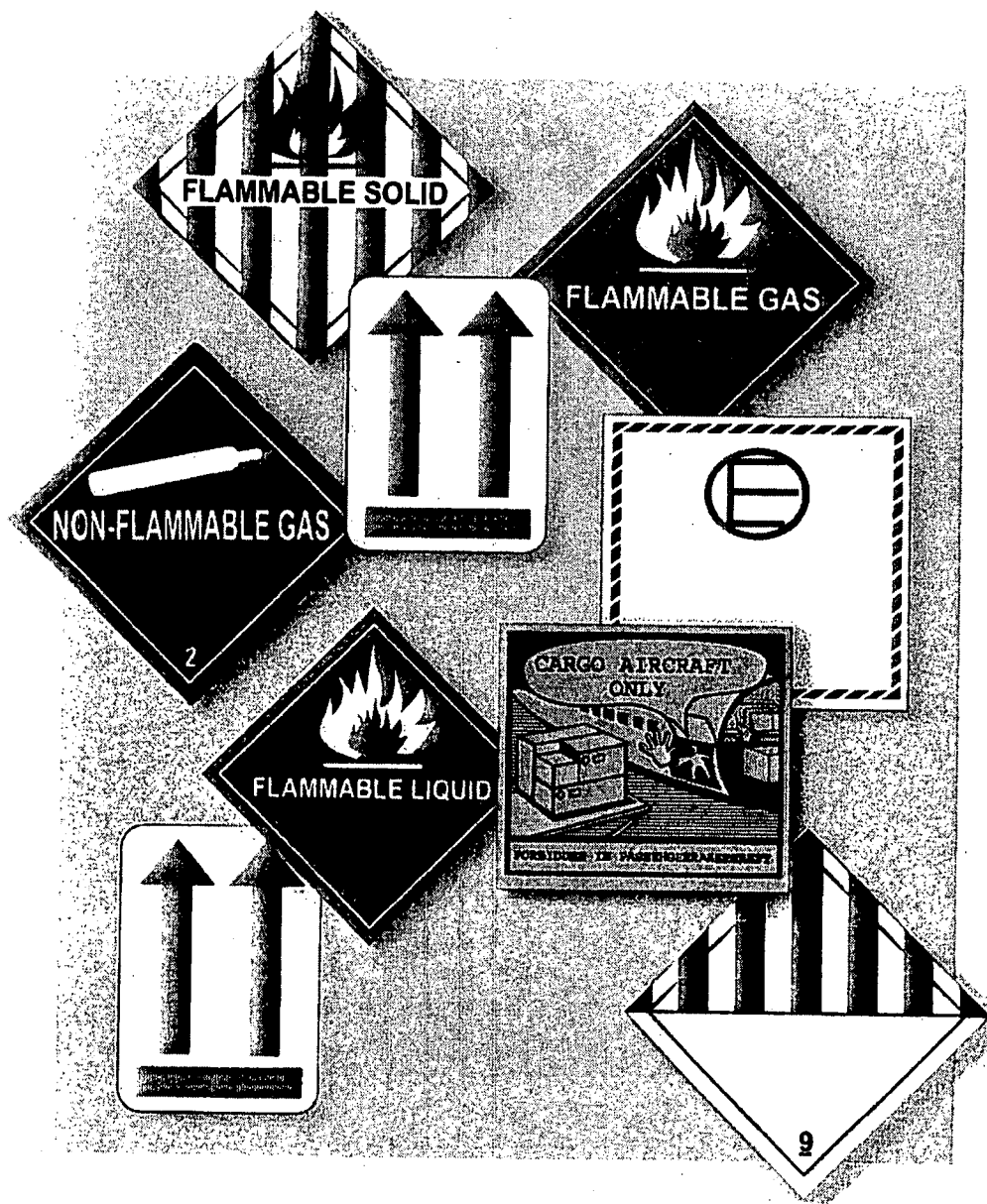
PR provides preliminary results. Requests for preliminary results will increase analytical costs.

Send Copy to: Sample Management Office, Attn: Kristin VonMoll, CSC, 15000 Conference Center Dr., Chantilly, VA 20151-3819; Phone 703/818-4235; Fax 703/818-4502

APPENDIX B

**WESTON:
MANUAL OF PROCEDURES FOR SHIPPING AND TRANSPORTING DANGEROUS
GOODS (excerpts)**

Weston Solutions, Inc. Manual of Procedures for Shipping and Transporting Dangerous Goods



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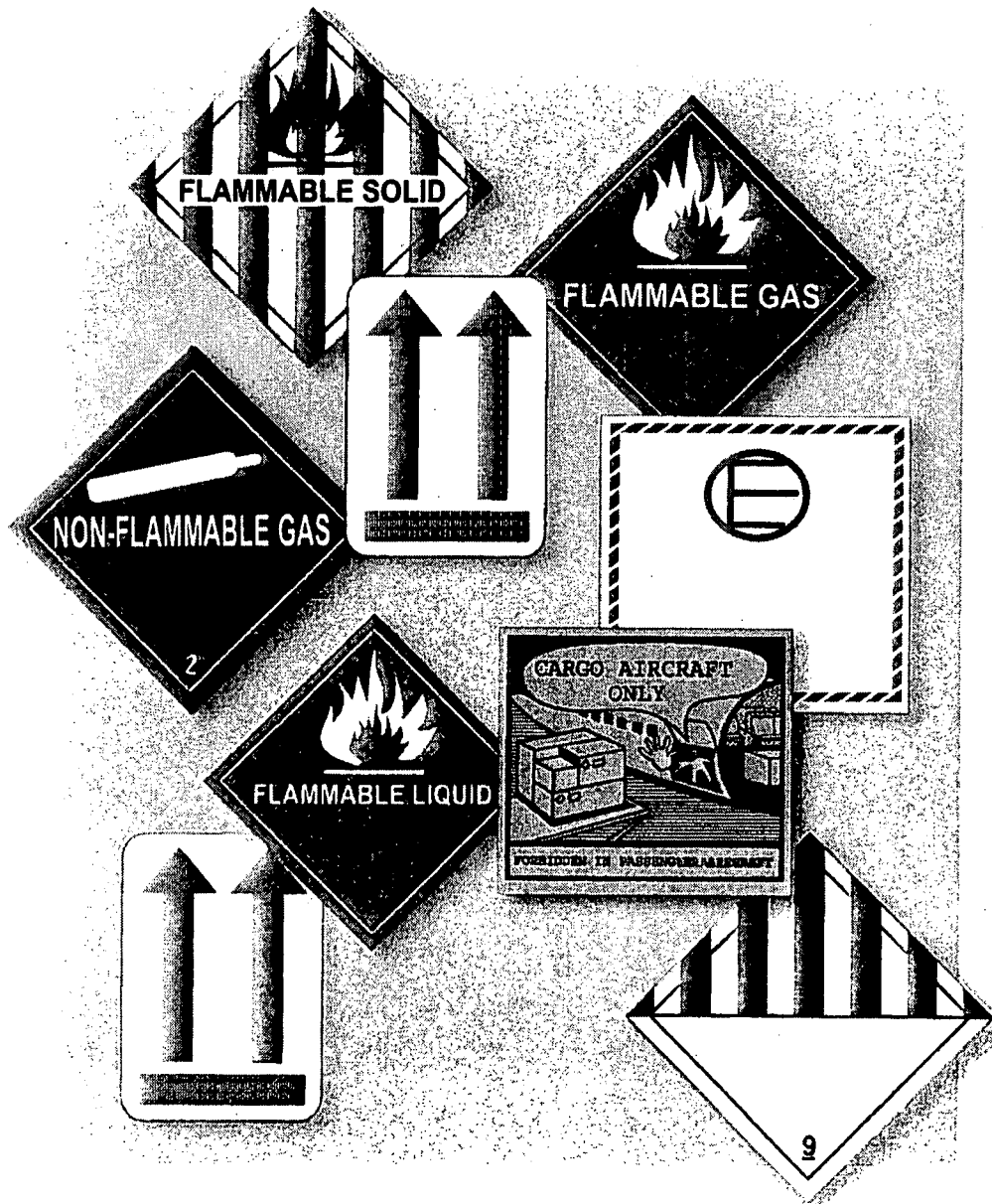
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APPENDIX B Dangerous Goods Management and Transportation Baseline Security Plan

SECTION 1

Procedures for Shipping Dangerous Goods by Air



General Requirements for All Packages

These guidelines are limited to shipments within the United States (USA, AK, and HI).


Before sending a package of dangerous goods or hazardous materials for shipment by air, you must comply with the procedures described below.

You must verify that the dangerous goods are not prohibited from being transported by air. If the articles or substances are allowed to be shipped by air, they must be properly identified, classified, packed, marked, labeled, and documented according to appropriate regulations.

Regulations Shipments for Federal Express must meet the requirements of the documents from the International Air Transport Association (IATA) on regulations for dangerous goods. Anyone who violates the regulations for shipping articles or substances may be subject to penalties.

Packing Requirements When preparing a package that contains dangerous goods for air transport, you must comply with the IATA packing requirements. The overall quantity in the package must not exceed the limits specified in the IATA regulations for passenger and cargo aircraft. In addition, the quantity in each inner package must not exceed the limits specified in the IATA regulations.

You must pack dangerous goods in packaging that can withstand transport by air and that meets the IATA requirements. The WESTON standard procedures that start on page 1-16 meet those requirements. In addition, you must remember the following facts and follow the described procedures.

Labeling When you place a package-position label  on a package, the words "This End Up" or "This Side Up" may be displayed on the top of the package.

When you reuse packaging, remove all inappropriate marks and labels that refer to dangerous goods. If the labels and marks cannot be removed, cross them out so that they are not visible. Reused packaging must comply with the package strength requirements described on the following page.

Incompatible Substances Inner packages that are placed in outer packages must not contain substances that can react with each other or with dangerous goods that require segregation according to IATA regulations.

For example, you must not ship a "corrosive" (see the "Definitions" section, page 1-14), such as nitric acid, with another corrosive, such as sodium hydroxide, because the two items will react violently if mixed together.

Verify that the cushioning or absorbent material will not react dangerously with the contents of the inner packages.

Inner Packages Inner packages must be packed, secured, or cushioned in a way that prevents breaking or leaking, and that controls movement of the inner containers within the package during normal conditions of shipping.

General Requirements for All Packages

(Continued)

Absorbent or Cushioning Materials The absorbent or cushioning material must not react with or be affected by the contents of the inner packages if the contents leak into the absorbent or cushioning material. The absorbent and cushioning materials specified in the procedures meet the requirements.

Packing Group Most hazards in the IATA definition of "dangerous goods" have a packing-group number that is based on the degree of the potential danger of the substance. Packing Group I is for the most dangerous goods. Packing Group II is for moderately dangerous goods, and Packing Group III is for the least dangerous goods.

Packaging Materials Packaging, including closures (devices such as caps and lids), that closes openings in receptacles (containers) and is in direct contact with dangerous goods must be resistant to the dangerous goods. The materials that the receptacles are made of must not contain substances that may react dangerously with the contents, form hazardous products, or significantly weaken the receptacles. Closures supplied by vendors usually meet the requirements. The outer packaging specified in the procedures meets the requirements.

Closures must be held securely in place, that is, they must be screwed on or snapped on straight and they must be tight.

Package Strength **Package Performance Test:** (1) Drop Test: The package, as prepared for transport, must be capable of withstanding a 1.2 m drop test onto a rigid, non-resilient, flat, horizontal surface, in a position most likely to cause the most damage. After the test, the outer package must not show any damage which is likely to affect safety during transport and there must be no leakage from the inner packaging(s). (2) Stacking Test: Each package offered for transport must be capable of withstanding, without breakage or leakage of any inner packaging and without significant reduction of effectiveness, a force applied to the top surface, for a duration of 24 hours, equivalent to the total weight of identical packages if stacked to a height of 3 m (including the test sample).

Documentation WESTON's primary Dangerous Goods carrier is FedEx. FedEx has established certain carrier-specific requirements regarding the carriage of Dangerous Goods that **MUST** be followed. Two of these requirements, set forth below, apply to the documentation necessary for shipping (the *Shipper's Declaration of Dangerous Goods*).

FedEx requires that the majority of the *Shipper's Declaration* be either type-written or computer-generated. This may require that *Shipper's Declaration* be prepared in advance and completed in the field, or that shippers return to a WESTON office and prepare their *Shipper's Declaration* instead of shipping directly from the field. Shipments may have the name and address of Shipper (WESTON) and Consignee (FedEx), air waybill, airport of departure/destination, RQ, technical name, number of packages, quantity, unit of measure, name/title, signature, and place/date entered by hand on the *Shipper's Declaration*; however, WESTON's

General Requirements for All Packages

(Continued)

experience is that there are less problems when the majority of the form is typed (obviously, the signature must be handwritten). WESTON has form templates available for completing *Shipper's Declarations* with a minimum of effort: (1) Word template not containing the *Shipper's Declaration* form in the file (*for printing onto a blank Shipper's Declaration form*), and (2) Word document containing the *Shipper's Declaration* form in the file (when using this template, it **MUST** be printed on a color printer because the red and white striped border must be in color to satisfy IATA regulations).

FedEx also requires that three (3) copies of the *Shipper's Declaration* MUST be provided with each shipment.

Be sure to comply with these requirements.

Shipping Procedures On the following pages, specific procedures are described for dangerous goods that are shipped often. The procedures must be followed. Included in the discussion of the procedures for each item is an illustration of a package and its contents. The diagram shows how much each inner receptacle can hold, and shows the marked and labeled completed package.

Following the discussion of the procedure for each material is an example of a completed Federal Express airbill.

If you have any questions about a shipment of dangerous goods, please contact a **WESTON Dangerous Goods Shipping Advisor** (refer to page 1-5)

OR

Federal Express, Dangerous Goods Personnel

Phone: (800) 238-5355

(800) 463-3339

Extension 922-1666

Retention of Shipping Documents IATA and DOT have requirements for Shippers Declaration retention for 2 years for Dangerous Good/Hazardous Materials and 3 years for hazardous waste.

WESTON's Best Practice requires retention for 3 years.

NOTE: For items not listed in this manual, you **MUST** obtain guidance from a WESTON Shipping Advisor (see Page 1-5). Specifications for proper shipment **MUST BE** documented in an e-mail from the Shipping Advisor. A copy of the e-mail **MUST BE** printed out and attached to the record copy of the dangerous goods declaration.

General Requirements for All Packages (Continued)

Chem-Tel Chem-Tel is WESTON's Emergency Information provider for first responder type of information (e.g., as would be found on a MSDS) for dangerous goods shipments.

Chem-Tel has been provided with MSDS and/or chemical data for items listed in the manual.

If you are shipping an item that is **NOT** listed in the manual, you must provide the following information to Chem-Tel:

MSDS or Chemical Data Sheet(s)

Date of Shipment

Quantity

Ship To and From

WESTON Contacts (2) — provide a telephone number for each contact that can be reached during the shipping period

This information should be sent to Chem-Tel at the following e-mail address: weston@chemtelinc.com. Attach a copy of the e-mail to the record copy of the dangerous goods declaration.

Batteries Contained In or Packed With Equipment

All small batteries commonly used in air monitoring or other equipment must be securely packaged with or in the equipment in such a way that prevents the dangerous evolution of heat, fumes, gases, or fire, and protects against short circuits. Properly cushion items to prevent shifting, and ensure batteries are packed or installed to prevent battery terminals from contacting each other or short circuiting.

Rechargeable lithium batteries (also called lithium ion (Li-ion), or secondary lithium batteries), and non-rechargeable lithium batteries (also called lithium metal, or primary lithium batteries), provide more energy and a longer operating life than other battery chemistries. They have the potential to generate a significant amount of heat or catch fire if damaged or improperly packaged, cared for, or constructed than do other batteries.

Small rechargeable lithium batteries shipped in/with equipment require no special packing, labeling, or marking, except secure packaging as described above.

Small non-rechargeable lithium batteries must be shipped as dangerous goods, cargo aircraft only, and are not included in this manual. Either ship the equipment without the batteries or contact a WESTON Shipping Advisor (see Page 1-4).

For larger batteries, automotive or marine batteries, batteries of unusual design or containing exotic metals or fluids, contact a WESTON Shipping Advisor.

General Requirements for All Packages (Continued)

Weston Dangerous Goods Shipping Advisors For Shipments By Air (FedEx)

	Name	Location	Telephone No.
Northeast	Alanna Garrison	EDC	732-417-5893
	Steven O'Brien	GCT	860-368-3215
	Joseph Schmidl	BNH	603-656-5461
	Marie Swiech-LaFlamme	BNH	603-656-5474
	John Brennan	ED2	732-585-4425
	Paul Callahan	BT1	978-552-2129
	Eric Ackerman	BT1	978-621-1203 978-552-2127
Mid-West	Steve Berry	MOH	937-384-4220
	Eric Keeley	VHI	847-918-4097
	Linda Korobka	OMI	517-381-5936
	Ted Deecke	PKY	847-337-4147
Pacific/Mountain	Danny Newman*	HOU	713-796-0040
South Division	Patrick Mack*	IAS (WC)	610-721-6519
	Danny Newman	HOU	713-796-0040
	Tracy Landers	AUB	334-466-5647
Mid-Atlantic	Larry Werts*	WC	610-701-3912
CEHS	Owen Douglass*	WC	610-701-3065
	Conrad Lehr*	WC	610-701-3725

* DOT (Ground) Shipping Advisor

Definitions

- Cargo Aircraft** An aircraft, other than a passenger aircraft, that carries goods or property.
- Combination Packaging** A combination of packaging consisting of one or more inner packagings (bottles) secured in a nonbulk outer packaging (box, cooler).
- Dangerous Goods** Dangerous Goods are articles or substances that are capable of posing a risk to health, safety, property, or the environment and that are shown in the list of dangerous goods in the IATA Regulations, which are classified according to the IATA Regulations.
- Gross Weight** The weight of packaging material plus the weight of the contents of the package.
- Hazardous Materials** Hazardous Material means a substance or material that has been determined by the Secretary of Transportation, U.S. DOT, to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and that has been so designated. The term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials as defined in the DOT regulations, materials designated as hazardous under the provisions of Sec. 172.101 of the regulations, and materials that meet the defining criteria for hazard classes and divisions in part 173 of the regulations.
- IATA** International Air Transport Association.
- Inner Packaging** A container for which an outer package is required for transport.
- Net Weight** This is the weight of the hazardous constituents in the container, not necessarily the weight of the contents of the container — example if you have 100 grams of soils with PCBs at 100,000 ppm, you only have 10 grams of PCBs and 90 grams of inert soil — this may make a difference in the use of limited quantity provisions.
- N.O.S.** Not otherwise specified.
- Aviation Regulated Solid or Liquid** Any material which has narcotic, noxious, irritating, or other properties such that, in the event of spillage or leakage on an aircraft, could cause extreme annoyance or discomfort to crew members so as to prevent the correct performance of assigned duties. The materials included under this proper shipping name must not meet any of the definitions for Classes 1 through 8.
- Outer Packaging** The outer part of a composite or combination packaging together with absorbent materials, cushioning, and other components necessary for containing and protecting inner packages.
- Overpack** An enclosure used by a single shipper to contain one or more packages and to form one handling unit for convenience of handling and stowing. Packages of dangerous goods in the overpack must be properly packed, marked, and labeled, and must be in proper condition.

Definitions

(Continued)

- Package** Packaging (that is, the box, inner bottles, product, and absorbent) plus contents.
- Packaging** The assembly of one or more containers and other components necessary to comply with the minimum packaging requirements of this document.
- Packing Group** A category indicating the relative degree of danger presented by various articles and substances within a class or division. Roman numerals I, II, and III are used to represent "great danger" (Packing Group I), "medium danger" (Packing Group II), and "minor danger" (Packing Group III).
- Passenger Aircraft** An aircraft that carries any person other than a member of the flight crew, a company employee, an authorized representative of the United States, or a person accompanying a shipment.
- Proper Shipping Name** The complete name of the hazardous material as shown in the IATA list of dangerous goods in bold type or as specified in the guidelines. (See Generic Descriptions below.)
- Quantity Limit** The maximum amount of a hazardous material allowed per package.
- Receptacle** A container, including closures, for holding substances or articles.
- Single Packaging** Packaging that does not require inner packaging to perform its containment function during transport.
- Generic Descriptions** When an article or substance is not listed by name in the List of Dangerous Goods, generic descriptions are authorized for use as technical names if they readily identify the general chemical group. Examples of acceptable generic descriptions are the following:
- Alcohols, N.O.S.
 - Ethers, N.O.S.
 - Flammable Liquid, N.O.S.
 - Corrosive Liquid, Toxic, N.O.S.
- UN Number** A four-digit number assigned to a particular dangerous good, preceded by the letters UN (United Nations), to help identify the hazard associated with the substance in case of emergency.

Guidelines for Classifying Field Sample Shipments

1.0 SHIPMENT OF HAZARDOUS MATERIALS

If the shipment of samples involves overnight shipment by air, IATA DGR must be applied. FedEx only accepts dangerous goods, including samples, for shipment if current IATA DGR, as modified by DOT, are followed. WESTON personnel must be careful to use only current IATA DGR, which are updated annually. Versions of IATA DGR more than one year out of date should be discarded.

In almost every case, including circumstances where WESTON personnel transport samples to laboratories or air couriers themselves or the samples are relinquished to a laboratory courier, DOT Hazardous Materials Regulations (49 CFR 171 to 178) must be applied. In most cases, the DOT regulations are similar to IATA regulations, but may include special variations.

In determining the shipping requirements for dangerous goods, shippers are responsible for identifying proper shipping names; UN Numbers; hazard class/ packing group; and packaging, marking, labeling, and documentation requirements applicable under IATA or DOT regulations. WESTON personnel involved in handling, packing, and shipping dangerous goods must be trained to correctly apply the regulations to the materials which they are shipping.

For known or suspected dangerous goods transported by vehicles to a shipping point or laboratory in WESTON-owned, leased, or WESTON employee-owned vehicles over roads or highways of the United States, DOT Hazardous Materials Regulations must be followed. This includes hazardous materials brought to a site (i.e., decontamination solvents, sample preservatives, fire extinguishers, calibration gases, etc.) as well as samples collected and any investigation-derived waste generated while at the site. Following current IATA DGR will ensure compliance with DOT Hazardous Material Regulations, as long as any potential State Variations listed for DOT are also followed.

One important item to consider is documentation. The IATA Shippers Declaration for Dangerous Goods for air transport will also cover the documentation requirement for ground shipment under DOT Hazardous Material Regulations. However, if the shipment is not to be shipped via air (i.e., to be delivered directly to the laboratory), the hazardous materials in the shipment, as well as all the other hazardous materials carried in the vehicle (as noted in General Requirements) must be documented. For this reason, WESTON has developed a Field Sampling Bill of Lading which can be used to fulfill the DOT Hazardous Material Regulations documentation requirement. These forms are pre-customized to each WESTON office, to simplify their preparation, and include commonly carried samples which qualify as

hazardous materials identified by proper shipping name with UN Number, Hazard Class, and Packing Group. The WESTON carrier simply needs to add any hazardous materials carried but not already included on the form; indicate the total quantity of each of the listed hazardous materials (leaving the column blank for hazardous materials pre-entered on the form but not included in the shipment); and sign, and date the form. The Field Sampling Bill of Lading and emergency response information must be carried in the front seat of the passenger compartment of the vehicle as earlier indicated and should be easy for emergency response personnel to locate in the event of an accident.

ALSO REFER TO SECTION 2, PAGE 2-1 "MATERIALS OF TRADE."

2.0 SHIPMENT OF SAMPLES

All samples, whether they qualify as hazardous materials or not, must be transported at all times in a manner that will maintain their integrity as well as protect against the detrimental effects from the sample containers leaking or breaking. IATA DGR and DOT regulations provide detailed descriptions of the packaging, marking, and labeling requirement for dangerous goods/hazardous materials. However, given the expense and effort made by WESTON to collect any sample, all samples must be packed in a manner that will ensure their safe arrival at their destination. In addition, even non-hazardous sample shipments which leak, even seemingly innocuous materials as melted ice or vermiculite dust, could become a nuisance or a hazard to an air carrier. Therefore, WESTON provides the following guidelines for shipment of all samples which are not shipped as dangerous goods.

It is imperative that all possible means be used to ascertain whether samples shipped by WESTON personnel have characteristics which would meet the criteria of the nine classes of dangerous goods/hazardous substances under IATA/DOT regulations. These criteria are presented in an abbreviated, field-oriented format in Section 2.2 of this document. If samples collected by WESTON do not meet any of the criteria outlined, they are considered Non-hazardous Materials Samples and handled as described in Section 2.1.

In addition to samples which contain hazardous substances, some samples become hazardous due to their preservation following collection. Aqueous samples are commonly preserved with acids and bases, and some soil samples are preserved with solvents. The hazardous materials contained in the preservatives make the samples Hazardous Materials Samples, with

certain exceptions. In the case of aqueous samples (i.e., water samples preserved with acid to a pH < 2) the entire volume of the sample becomes a hazardous material, where, in the case of solvent-preserved soil samples, only the volume of the solvent used is considered for determination of volume. This additional information, shared with a Dangerous Goods Shipping Advisor during the planning stages of a project, can simplify the shipping process and significantly reduce shipping costs.

The exceptions to these rules are established in U.S. Environmental Protection Agency regulations (40 CFR 136, as footnote 3 to Table II (Required Containers, Preservation Techniques and Holding Times)) for four hazardous substances commonly used to preserve aqueous samples: hydrochloric acid, nitric acid, sulfuric acid, and sodium hydroxide. As long as pH does not drop below 2 (for acids) or above 12 (for sodium hydroxide), the samples have been determined by DOT to not qualify as hazardous materials of Class 8 (Corrosives). Samples preserved according to these criteria can be shipped as Non-hazardous Materials Samples.

2.1 Environmental Versus Hazardous Materials Samples

Before packing, the outside of each sample container should be cleaned, preferably by rinsing with deionized water; care should be taken not to use detergents or solvents (which might contaminate the sample). Next, each sample container must be enclosed in a watertight polyethylene bag, to prevent cross-contamination in the event that any container in the package leaks or breaks. Next, each breakable sample container (i.e., glass) must be cushioned to prevent damage by impact with other containers. Finally, the samples should be packed in the package in a single layer.

The package used to ship the samples must be watertight and contain absorbent material if aqueous samples or water ice are included in the package. This is typically accomplished by lining a cooler or box with a plastic bag underlain with non-reactive, absorbent material which is sealed after samples are enclosed. If the samples must be kept cold during shipment, ice should be placed directly on top of the single layer of samples. Ice packs are preferable to water ice, as water ice will melt and potentially leak from the package. If water ice is used, it should be packed in watertight polyethylene bags, inside the inner liner bag with the samples, to prevent leakage; ice should not be shipped in the bags it is sold in, which are too thin and rarely watertight.

Finally, the package must be sealed with strapping or packing tape. Be sure to tape closed any drain spout on the cooler. Remember, the package should be packed in such a way that it and the materials inside are able to withstand a drop of 4 feet.

The package must be marked "Environmental Sample(s)". For packages containing liquids (including water ice), the package must be marked with arrows indicating the top of the package on at least two opposite sides. No special shipping paperwork is required, unless dry ice (see Carbon dioxide, solid, UN 1845) is used as a cooling medium.

2.2 Known or Potentially Hazardous Materials Samples

Samples which have characteristics by which they meet the criteria of the nine classes of dangerous goods/hazardous substances under IATA/DOT regulations, must be considered hazardous materials samples and must be shipped according to IATA/DOT regulations. However, in the case of samples collected by WESTON personnel and shipped for laboratory analysis, WESTON personnel may find themselves in the position of not knowing what hazardous substance is responsible for the characteristics which make the sample hazardous.

In many cases, background information related to the source of the sample, such as operational history and previous analytical results, can provide clues regarding the specific hazardous substances associated with the sample. In fact, many hazardous substances, such as polychlorinated biphenyls (PCBs), which are considered hazardous substances at low concentrations in inert media, cannot be detected with typical field screening instruments (excepting field test kits). In such cases, background information is critical to the proper characterization and shipping of the samples, by allowing WESTON personnel to make informed assumptions regarding the possible hazardous materials contained the samples and their concentrations. Please note IATA and DOT regulations do not have minimum quantity thresholds below which a hazardous material is not considered a dangerous good for shipping purposes.

The rationale used to determine how to ship samples containing unknown hazardous substances is outlined in DOT regulations (49 CFR 172.101(d)(11)). This section states that "a material for which the hazard class is uncertain and must be determined by testing...may be assigned a tentative shipping name, hazard class, and identification number, based on the shipper's tentative determination" based on the criteria of the established hazard classes, hazard precedence (see table on page 1-15), and the shipper's knowledge of the material.

If WESTON personnel, based on their knowledge of site operational history and/or analytical results of samples previously collected from the site, believe that the samples they are shipping constitute hazardous materials, then the samples must be shipped according to IATA/DOT regulations, as

applicable. Where possible, the specific hazardous substances associated with the site should be included in the proper shipping name, where applicable. This additional information shared with a Dangerous Goods Shipping Advisor during the planning stages of a project can simplify the shipping process and significantly reduce shipping costs.

In cases where site operational history and/or analytical results of samples previously collected are incomplete or not available, WESTON has developed the following screening procedures to ascertain, to the degree possible in the field, whether samples collected have hazardous properties. The following hazardous characteristics need to be considered.

Explosives (Class 1)

Explosives are banned from air shipment and require special ground transport. Any site where explosives are suspected or discovered will be screened by specialized personnel, and sample handling and shipping will be directed by these personnel.

Radioactivity (Class 7)

Radioactive materials require special handling for air shipment and ground transport. Any site where radioactive materials are suspected or discovered will be screened by specialized personnel, and sample handling and shipping will be directed by these personnel.

Radioactivity hazards can be ruled out by a knowledge of the site, materials sampled, or screening of the samples with an appropriate Ionizing Radiation Detector.

Hazardous Gases (Class 2)

Gases are defined as substances which are gases at 20°C (68°F) at a pressure of 760 mm Hg. For the most part, gases are contained in cylinders under pressure. Hazardous gases are subdivided into three Divisions: Flammable Gas (Division 2.1), Nonflammable Gas (Division 2.2), and Toxic Gas (Division 2.3).

Gases will not be found in appreciable quantities in containers other than cylinders, nor will they persist in soil or water samples. Cylinders containing unknown gases will require specialized testing to determine their contents prior to shipping.

Oxidizers and Peroxides (Class 5)

Oxidizers (Division 5.1) and Organic Peroxides (Division 5.2) typically will be found in containers. In most cases, these substances react quickly with the environment when released, which neutralizes their hazard; therefore, they are unlikely to be found in samples of inert media (i.e., soil or water) in forms which still possess hazardous characteristics.

In screening the contents of containers, oxidizers can be detected based on elevated oxygen readings on a CGI/O₂ meter. Peroxides can be detected in the field using test strips. Peroxides may not be shipped by air under IATA regulations.

Toxicity (Class 6)

Knowledge of the hazardous materials at the site will be the primary means of determining the presence of toxic substances in samples collected from sites, as there are no known field tests for general "toxicity."

Flammability (Classes 3 and 4)

The characteristic of flammability defines Flammable Liquids (Class 3) and Flammable Solids (Class 4). Field screening for flammability is performed using a CGI meter to screen sample headspace. For the purposes of sample shipping characterization, WESTON considers samples with headspace LEL of 25% or greater to be flammable materials. Elevated readings on a PID or FID will indicate the presence of volatile organic compounds (VOCs), and should be used as a cue to screen samples for LEL to determine flammability. Elevated PID or FID headspace alone is an extremely conservative criteria to characterize a sample as flammable, as VOCs are detectable at concentrations orders of magnitude below those which constitute a flammability hazard.

The class of hazardous materials known as Flammable Solids includes, Substances Liable to Spontaneous Combustion (Pyrophoric and Self-reactive substances), and Substances which, when wet, emit flammable gases. These substances would not likely be detectable by screening with a CGI meter, but their presence would be apparent as containers were opened and heat, smoke, or vapors were produced as they reacted with air or moisture. Samples must be carefully observed for these types of hazards. As in the case of oxidizers, these substances are not likely to be found included in inert media, as they would have reacted with the environment upon their release, and would now likely be inert byproducts of their reaction.

Soil samples contaminated with VOCs are commonly collected and shipped. As the solid matrix of the sample is inert, the samples should be classified as Solids Containing Flammable Liquids if they meet the CGI headspace screening criteria.

Corrosivity (Class 8)

In order to rule out corrosivity, samples must be tested for pH, and found to have a pH greater or equal to 2.0 and less than or equal to 12.5. For liquid samples, a small amount of sample can be tested directly by pH paper or a pH meter. For solid samples, a small amount of sample can be mixed with deionized water (pH 7) and the resulting mixture tested for pH after the mixture is allowed to equilibrate.

Miscellaneous Hazards (Class 9)

Several Miscellaneous Hazards have also been identified by IATA/DOT, including Magnetized Material, and Aviation Regulated Solids or Liquids (materials which have narcotic, noxious, irritating, or other properties which could cause extreme annoyance or discomfort to aircraft crew members if they were to leak from their containers). These characteristics should be identifiable during sample collection. Professional judgement must be exercised in determining whether samples with strong or foul odors should be shipped as Miscellaneous Dangerous Goods. In many cases, WESTON personnel have defaulted to this category when no other hazard was identified. This default is perfectly reasonable, but it should be noted that the additional expense of sample packing, shipping, and documentation is not required unless a miscellaneous hazard is identified.

Summary

The following table summarizes the field screening tests to be performed on samples suspected of having hazardous characteristics.

<u>Hazard</u>	<u>Test</u>	<u>Hazard Criteria</u>
Radiation	Screen with a sodium iodide microR meter, and possibly a Geiger-Mueller meter	Readings greater than three times background indicate radioactivity.
Peroxides	Peroxide test strips	Positive results indicate peroxide
Pyrophoric/ Self-reactive	Observation of sample	Observation of sample heating or generation of smoke or vapor suggests instability which requires special handling
Flammability	Screen with Combustible Gas Indicator (CGI) meter	Greater than or equal to 25% of lower explosive limit (LEL) suggests flammability
Corrosivity	pH test paper or pH meter	pH less than 2.5 or greater than 12 suggests corrosivity
Miscellaneous	Observation of sample	Professional judgement that the sample would be considered to have narcotic, noxious, irritating by flight crew if released.

Hazard Precedence

Once the hazard(s) associated with a sample have been determined, a Proper Shipping Name must be applied to the hazardous material, in order to determine the proper packing, marking, labeling, and documentation required to ship the material. Samples from containers which fall into other categories (Explosives, Gases, Oxidizers, and Peroxides) should be shipped according to guidance from a WESTON Dangerous Goods Advisor. The following table lists the likely hazards encountered in samples of inert media (i.e., soil or water) in order of decreasing hazard.

<u>Hazard</u>	<u>Subsidiary Hazard</u>	<u>Proper Shipping Name UN Number</u>
Explosive		Requires guidance from an explosives material specialist
Radioactive		Requires guidance from a radioactive materials specialist
Flammable Solid	None	Flammable solid, organic, n.o.s., sample, UN 1325; or Flammable solid, inorganic, n.o.s., sample, UN 3178
	Corrosive	Flammable solid, corrosive, organic, n.o.s., sample, UN 2925; or Flammable solid, corrosive, inorganic, n.o.s., sample, UN 3180
Solids containing Flammable Liquid		Solids containing flammable liquid, n.o.s., sample, UN 3175
Flammable Liquid		Flammable liquid, n.o.s., sample, UN 1993
	Corrosive	Flammable liquid, corrosive, n.o.s., sample, UN 2924
Corrosive		Corrosive liquid, n.o.s., sample, UN 1760; or Corrosive solid, n.o.s., sample, UN 1759
Miscellaneous		By specific hazard (i.e., Magnetized material, UN 2807), or general (i.e., Aviation regulated liquid, n.o.s., sample, UN 3334; or Aviation regulated solid, n.o.s., sample, UN 3335)

Hazardous samples being transported for further testing may not be packed together with other goods, such as, non-hazardous samples. They must be shipped in a separate package.

Transport of hazardous materials via ground, including circumstances where WESTON personnel transport materials such as decontamination chemicals or other hazardous materials, transport samples to laboratories or air courier drop-off locations, or where WESTON contracts shipment via ground using common carriers or a laboratory courier, U.S. Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR 171 to 178) must be applied. In most cases, the DOT regulations are similar to IATA regulations. In most cases, the DOT regulations are similar to IATA regulations. Specific guidance is outlined in 49 CFR 171.11. Contact a Dangerous Goods Advisor if there are any questions or concerns.

Documentation is required for all shipments of dangerous goods. The IATA Shippers Declaration for Dangerous Goods which is required for air shipments, will also satisfy the documentation requirement for ground shipment under DOT Hazardous Material Regulations. One should remember, however, that all the hazardous materials carried in the vehicle must be documented, including those which have not been prepared to be shipped from the field. This includes hazardous materials brought to a site (i.e., decontamination solvents, sample preservatives, fire extinguishers, calibration gases, etc.) as well as samples collected and any investigation-derived waste generated while at the site.

To fulfill the documentation requirement for ground transport, WESTON has developed a Field Sampling Bill of Lading. These forms are pre-customized to each WESTON office, to simplify their preparation, and include commonly carried hazardous materials, identified by proper shipping name with UN Number, Hazard Class, Packing Group. The sampler simply needs to add any hazardous materials carried but not already included on the form; indicate the total quantity of each of the listed hazardous materials (leaving the column blank for hazardous materials pre-entered on the form but not included in the shipment); and sign, and date the form. The Field Sampling Bill of Lading must be carried in the front seat of the passenger compartment of the vehicle, be within reach of the driver, be on the drivers seat or driver side door when the driver is out of the vehicle and should be easy for emergency response personnel to locate in the event of an accident.

Refer also to *Appendix A—Materials of Trade Exceptions*.

Additional material necessary for the transport of hazardous materials is the DOT Emergency Response Guidebook (ERG) or the appropriate MSDS(s) for the chemicals transported. These materials must be stored with the shipping paper (Bill of Lading) identified above.

Note: 24 Hour Emergency Contact Phone Number for Air Shipments: 1-800-255-3924

U.S. DOT Hazardous Materials Classification (49 CFR 173.2)
Listed in Order of Descending Hazard

- (1) Class 7 (radioactive materials, other than limited quantities).
- (2) Division 2.3 (poisonous gases).
- (3) Division 2.1 (flammable gases).
- (4) Division 2.2 (nonflammable gases).
- (5) Division 6.1 (poisonous liquids), Packing Group I, poisonous-by-inhalation only.
- (6) A material that meets the definition of a pyrophoric material in § 173.124(b)(1) of this subchapter (Division 4.2).
- (7) A material that meets the definition of a self-reactive material in § 173.124(a)(2) of this subchapter (Division 4.1).
- (8) Class 3 (flammable liquids), Class 8 (corrosive materials), Division 4.1 (flammable solids), Division 4.2 (spontaneously combustible materials), Division 4.3 (dangerous when wet materials), Division 5.1 (oxidizers) or Division 6.1 (poisonous liquids or solids other than Packing Group I, poisonous-by-inhalation). The hazard class and packing group for a material meeting more than one of these hazards shall be determined using the precedence table in 49 CFR 173.2 paragraph (b).
- (9) Combustible liquids.
- (10) Class 9 (miscellaneous hazardous materials).

Note: *Use of these Guidelines is intended for those Environmental Professionals who have fulfilled the training requirements contained in 49 CFR 172.704, 29 CFR 1910.120, or the IATA Dangerous Goods Regulations.*

APPENDIX C

USEPA REGION 2: GLOBAL POSITIONING SYSTEM STANDARD OPERATING PROCEDURES



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Global Positioning System Standard Operating Procedures

[Introduction](#) | [Roles and Responsibilities](#) | [Planing a GPS Project](#) | [Field Procedures](#)
[GPS Data Postprocessing](#) | [GPS Data in ArcView GIS](#) | [Appendices](#)

Introduction

This guidance document will provide a user with an understanding of EPA Region 2 requirements for collecting locational data with Global Positioning System (GPS) technology. This document will also provide guidance for processing GPS data and bringing it into our Region 2 Geographic Information System (GIS). The intended audience of this document includes EPA Region 2 staff, contractors and grantees who are involved in the following activities:

- Planning and oversight of a GPS data collection project
- Conducting GPS data collection in the field
- Maintaining and loaning GPS equipment
- Responsible for post processing GPS data from the field and it's conversion to Geographic Information's System (GIS) data layers and other data formats.

The Region 2 GPS Guidance Document has the following main topics:

1. [Roles and Responsibilities](#)
2. [Planning a GPS Project](#)
3. [Field procedures](#)
4. [GPS Data Post Processing](#)
5. [GPS Data Management In ArcView GIS](#)

GPS can consistently provide accurate locational data coordinates that meet the requirements of EPA's Locational Data Policy (LDP), as well as Regional 5 meter accuracy goals. This is possible when the project is conceived with proper planning, the equipment is used by trained individuals, and the data is postprocessed correctly. If the project is not planned properly the data will be incompatible with both EPA Program and GIS databases. If GPS data collection is poorly performed, or the data is not differentially corrected, GPS coordinates may only be within 100 meters of the actual location. Human error can add kilometers to this outcome.

Region 2 needs to insure that GPS data is collected with proper consideration of the Region's GIS as well as EPA national system (Program) databases. GPS data will be used to update locational information in these databases. The Region also must satisfy agency LDP. This policy applies to all EPA data collections that are locationally based. This policy requirement for collecting and documenting lat/long, as well as Method, Accuracy, and Description (MAD) information, applies to all existing as well as new locational data.

For GPS locational data, the Region's compliance with the LDP is supported by the GPS Field procedures, GPS data dictionaries, GPS post processing and GPS data management procedures established in these SOPs. Changes in these procedures will be driven by improvements in GPS technology and software.

Each Region 2 GPS data collection effort must start with approved GPS data dictionaries,

developed with the guidance of this document and the Information Systems Branch (212-637-3335 & 3595). These GPS data dictionaries can guide and organize the GPS data collection in the field so that the data will be useful for both scientific and information management purposes.

1. Roles and Responsibilities

A team made up of staff from Region 2's Policy, Planning, and Evaluation Branch (PPEB) and Information Systems Branch (ISB), have been responsible for operation and maintaining a Region 2 Geographic Information System (GIS). This team provides GIS training for Program staff and through cooperative efforts with Program offices, develops GIS applications. This approach distributes GIS capability to the individual who is then responsible for making use of it.

A similar framework exists for the Region 2 GPS program. GPS equipment and field operation oversight is managed by the Region 2 GPS Coordinator out of the Monitoring and Assessment Branch - DESA in Edison New Jersey. The Information Systems Branch - OPM in New York provides GPS data management and software support. The operative idea is *GPS data collection and post-processing is performed by EPA Program staff, grantees or contractors with the support and oversight of the managing framework*. All Region 2 supported GPS data collection efforts have a responsibility to deliver ArcView ShapeFiles and GPS metadata as described in the document to the Information Systems Branch. (See Section 5 in this document "GPS Data Management in ArcView GIS".)

Roles and Responsibilities for GPS use:

REGION 2 GPS PROGRAM responsibilities include:

- Determine which GPS vendor and hardware configuration is best for the Region 2 GPS Program. The Region 2 GPS coordinator purchases and maintains GPS equipment as required for the Region 2 GPS Program.
- Provide technical assistance and advice on use of GPS technology and keeping current with new developments in the field. All EPA Region 2 staff, contractors and grantees must get prior approval from the Region 2 GPS Coordinator before purchasing GPS equipment or software.
- Provides cost estimates of GPS training and coordinate GPS training for EPA staff, contractors and grantees.
- Loaning Region 2 GPS Program equipment as needed to qualified EPA staff, contractors and grantees.
- Maintains the Region 2 base station and base station data.
- Approve all GPS data dictionaries and provide guidance on database and GIS related issues.
- Receive all correctly formatted Region 2 GPS project data (See Section 5: "GPS Data Management in ArcView GIS").
- Incorporate all valid GPS project data into the Region 2 GIS Database.
- Establish and maintain Region 2 GPS SOPs

EPA PROGRAM CONTACT'S responsibilities include:

- Providing key identifying information such as EPA Program Facility and Sub Facility (feature) ID's for facilities in the GPS project. This information should be given to EPA staff, contractors or grantees who are doing the GPS field work, as requested.
- Working with Region 2 GIS Program staff to coordinate the transfer of GPS locational and attribute data between the Agency's GIS and Program databases.

GPS Project FIELD USERS responsibilities include:

- Receive training in the use of GPS equipment and Region 2 GPS data collection procedures.
- Become familiar with equipment, data dictionaries and file naming convention before going into the field.
- Collect GPS field locational data using Region 2 data collection protocols.
- Promptly returning GPS equipment on loan from the Region 2 GPS Coordinator upon completion of field work.

GPS Project POST PROCESSOR'S responsibilities include:

- Follow this document's guidance on the use of GPS Post Processing Software and Region 2's ArcView GPS Data Management Tool.
- Keep the GPS Project leader informed of GPS data quality.
- Promptly returning GPS software security keys on loan from the Region 2 GPS Coordinator upon completion of GPS project.

GRANT/CONTRACT ADMINISTRATOR'S & GPS PROJECT LEADER'S responsibilities include:

- Notifying Regional GPS Coordinator that a contract or grant involving collection of GPS locational data is being considered.
- Ensuring that grant or contract staff follow Regional GPS procedures when collection and post processing data.
- Ensuring that the data is delivered to EPA Region 2 Information Systems Branch in the format specified in this document.

2. Planing a GPS Project

To insure that the GPS survey is successful, appropriate planning activities must be undertaken before the survey is performed. Planning should include the following:

- The objective(s) of the project should be established.
- Database considerations and GPS data dictionary design.

- Post processing responsibilities delegated and file naming convention understood.
- GPS Field Survey requirements (Technical training, Field training & site knowledge.)

These four (4) planning steps are crucial to get accurate locational data that is compatible with EPA programs and GIS databases. Poor project planing can result in inaccurate or incomplete data.

2.1 Establishing the objective(s) of the Project

The objectives of the project should be clearly understood. Write down the purpose of the data collection and the type of data that is to be collected.

- Are you collecting new data, or improving your existing locational data? If new data is being collected for features that do not exist in an established data base, call GPS Program Data Management support at 212 637 -3335.
- Is it possible for you to collect data for more than one program? Determine which program(s) might be included in the GPS data collection effort.
- From the selected program(s), which features (locations) are going to be acquired with GPS (e.g., front door, main gate, discharge and/or monitoring locations, treatment unit...)? How should the desired features be represented (points, lines, polygons) ?
- What will be the physical extent and duration of the GPS data collection effort ?

At this time it should be understood that your locational data collection effort should meet Region 2 requirements. This means that the accuracy *goal* for collected data should be +/- 5 meters, that whenever unique ID's exist in Program and GIS databases they should be used in the data dictionaries, and that every GPS'd feature has Method Accuracy & Description attributes.

2.2 Database considerations and GPS data dictionaries design.

GPS Locational data must be relateable to existing EPA Program and GIS databases. The primary consideration after identifying the database related to your GPS data collection is to identify the unique ID or "key" used for the features you will locate. The unique identification of an EPA regulated point or area in a Program database will often require a Facility level as well as sub facility level ID and possibly more. The next step in the planing process is designing a good data dictionary with these identifying keys. Data dictionaries are created with the Trimble's PathFinder Office Software and loaded into the Datalogger. In the field, a data dictionary prompts the GPS field operator to enter the database key(s) and and other attribute information to identify the point or area being collected. This information will be automatically tagged or attached to the locational data (latitude and longitude). A well thought out data dictionary(s) should be designed and field tested prior to actual data collection.

To create a good data dictionary, the elements of each database involved in the project should be "mapped" or scrutinized in order to understand what are the key identification fields. In this way you can correctly choose the database fields that will uniquely identify the features for which you want to acquire GPS locations.

- Example: If you are interested in obtaining locational data for PCS (Permit Compliance System) monitoring points, you would need to enter the facility level ID (NPDES ID), the discharge pipe id (DSCH ID) and the monitoring point ID (DRID) in order to uniquely identify a PCS monitoring point.

All Region 2 data dictionaries must also contain the field "MAD_DESCRP". This field should provide a physical description of the feature whose location is being GPS'd. "MAD_DESCRP" is one of the Method Accuracy & Description (MAD) metadata attributes required by Agency LDP. *All other required MAD fields will be automatically generated by the "Region 2 GPS Data Mgmt. Tool-Trimble"* (See section 5."GPS Data Management in ArcView GIS").

A GPS data dictionary will have its own file for the day. A dictionary file can receive many points or areas. For each day of GPS data collection, one file for each data dictionary used that day should be created in each hand held GPS data collector. A single data dictionary is usually all that is required for most Region 2 GPS data collection efforts.

Data dictionaries can contain different types of point and area features. A particular point or area feature type, can be selected from a list in the data dictionary by the crew member operating the unit. Each feature will appear to the user as a separate data input screen. For example:

Permit Compliance System (PCS) GPS data projects, might use a data dictionary with three separate features: an *end of pipe discharge point* feature ("pcs_d_pt"), a *pipe monitoring point* feature ("pcs_m_pt") and a *discharge area* feature ("pcs_d_area"). They are each data dictionary features in the PCS data dictionary. Many features of these three types can be captured in the PCS data dictionary file for that day.

2.3 Post Processing Responsibilities and File Naming Convention

The Region 2 GPS Program can loan a secured copy of Trimble's post processing software, PathFinder Office Ver. 2.11, to EPA Region 2 staff, contractors and grantees. This software will run on any Region 2 PC or laptop computer running Windows 95 or higher. The software also runs on NT. The Information Systems Branch will help install the software on the dedicated computer for the GPS project (see Bob Simpson-ISB, 212-637-3335). File management for the GPS project is a very important consideration for any GPS data collection effort running more than one week. The correct handling of project data requires a consistent post processing team or individual to accept the responsibility. Section 4.1 in this document "Setting up the GPS Project Workspace" will guide the user to set up a well organized project workspace on the computer dedicated to postprocess the GPS project data. Once base station data has been downloaded, the post processing time allocation should not be much more than 3 hours for each GPS crew's weekly data. Daily post processing is preferred. Daily download and backup of GPS data is required.

The Region 2 file naming convention should be understood at the planing stage and should be followed at all times. Our file name convention provides for consistency among file names as well a way to locate the source data for quality control purposes.

The maximum number of daily GPS files created from one GPS crew, should be one file for each data dictionary used that day. Each file should be named using the Trimble default fill name with a small modification. The default file name has eight (8) alpha-numeric characters and should start with a default letter for the data collector used. This letter will have been set by the Region 2 GPS Program Coordinator and will be unique for each Region 2 Trimble Data Collector. This letter must not be changed. Following the first letter will be the month, day and military hour as 6 numbers. The 8th and last character is a letter. The user should backspace from the 8th through the 6th space (military style hour) in the default file name and modify these three characters to be a 3 character abbreviation for the data dictionary being used. These 3 characters will provide crew members with the ability to discriminate between the data dictionary file names on the data logger, if more than one data dictionary was used in a day..

For example, in the case of the PCS data dictionary, the Trimble default file name of

• E061117A should be modified to: E0611PCS

Remember, every data dictionary used for Region 2 GPS data collection efforts must be approved by the Information Systems Branch. Upon approval a 3 letter acronym for the data dictionary will be assigned.

2.4 GPS Equipment and Training

The purchase and or use of GPS equipment by EPA Region 2 Programs, Grantees, or contractors must be approved by the Regional GPS coordinator (Michael Glogower). This is necessary to

make sure that the equipment used for a regional project meet regional and agency requirements such as:

- Attribute entry (facility/site identification) capability
- EPA Locational Data Policy (LDP) Metadata creation
- Accuracy capability

Trimble Pro XR and XL GPS packages meet these requirements and can be loaned from the Region 2 GPS Coordinator. Personnel must be trained in the use of the GPS equipment and the Standard Operating Procedures before any data collection takes place. To arrange a training session with Region 2 Trimble equipment, contact the Regional GPS coordinator (Michael Glogower).

3. Field Procedures (GPS 001 - Revisions 03)

These field procedures were developed by the regional GPS coordinator Michael Glogower (Surveillance and Monitoring Branch) and approved by Randy Braun (Surveillance and Monitoring Branch) & Robert Runyon (Chief).

These GPS field procedures provides guidance for the use of EPA's Code-Based Global Positioning System (GPS) equipment. It gives guidelines for users of TRIMBLE Navigation's Pathfinder PRO XL and PRO XR GPS receivers with Trimble models (TDC1 & TSC1) hand held Datalogger as well as the older Corvallis Microtechnology (CMT) MC-V model Datalogger. These procedures will address topics that are necessary so that the reader has a basic understanding of what is involved in collecting locational data. This section will address a locational data project from start to finish, and will include; GPS project planning, recommendations for GPS survey planning, GPS equipment setup (Critical Parameters),GPS use and field notes.

GPS can consistently provide accurate locational data coordinates that meet the requirements of EPA's Locational Data Policy, but only when the GPS equipment is used by trained individuals, is coordinated with proper planning, and the data is postprocessed.

3.1 Planning a GPS Field Survey

To insure that the GPS survey is successful, appropriate planning activities must be undertaken before the survey is performed. These planning activities should include:

Facility/Site knowledge preparation.

Review of data dictionaries and file naming convention.

Factors that might limit the use of the GPS equipment should be assessed.

If a GPS survey is properly performed, and the data is differentially corrected (or postprocessed), users can expect to obtain accurate locational data that always meets the Regional GPS Policy goal of ± 5 meters. If the survey is not properly planned, is poorly performed, or the data is not differentially corrected, users can expect the results to be within 100 meters (95 percent of the time)of the actual location. GPS operates best when the receiver has a clear view of the sky. Problems can be experienced when working under very heavy tree cover, or in urban areas with large buildings.

The first step in the planning process should be to determine what sites, and which site characteristics, are going to be located. A plan should be formulated to collect the desired locational data in a logical manner, which makes the best use of the time available. Personnel should become familiar with the site(s) before data collection begins, and an effort should be made to determine

exactly where the locational data will be collected (i.e. at the front door, main gate, at the treatment unit, centroid of the site, etc.), this is called "feature mapping". Maps and directions to the site(s) should be obtained, and site maps are very useful to have in the field. For large or complicated Facilities a pre-survey meeting with the Facility Environmental Coordinator should be scheduled to 'feature map' desired points and areas.

If the field crew is going to be collecting information about the location ("attribute data") using the older Corvallis Microtechnology (CMT) MC-V model data logger, or more recent Trimble models (TDC1 & TSC1) data loggers, then a well thought out data dictionary should be designed and field tested prior to actual data collection. A data dictionary is used to provide data about the locational data collected, and although a data dictionary is not necessary to capture GPS positions, it makes sense to record relevant attribute information to the positional data collected. The information that the data dictionary can collect is attached to the location data, and it can be either site or program specific. A data dictionary is created on a PC using the PathFinder Office (Ver 2.11) software, and must be transferred from the PC to the data logger before it can be used.

The collection of locational data will be scheduled to coincide with proper satellite availability, and favorable satellite geometry, in order to optimize the accuracy of the locational data collected. GPS positions must not be collected unless at least four satellites are observed by the GPS receiver. In addition, satellite geometry must be favorable, and a Positional Dilution of Precision (PDOP) of six or less is available. Locational data should not be collected during periods when there are less than four satellites visible to the receiver and/or if the PDOP is greater than six.

In order to obtain GPS positions that meet the Regional LDP (i.e. ± 5 meters), the remotely collected data must be differentially corrected against a Base Station that is collecting data simultaneously, and which is within 200 miles (320 kilometers) of the Base Station. EPA's Base Station in Edison, New Jersey operates seven days a week from 7:00 am to 7:00 p.m. Several distances measurements from the Edison Base Station are shown in Table 1 attached.

The NJDEP in Trenton, New Jersey also operates a Base Station, however it operates only on weekdays from 7:00 am to 7:00 PM. Additional hours can be provided, if necessary by contacting the respective GPS Coordinator. Arrangements have been made with other Base Station operators so that complete coverage of the Region is provided. For northern New York State we may access the Vermont Agency of Transportation in Montpelier, VT, in western New York State we can access the Allegheny National Forests' Base Station, and in Puerto Rico we can access either Marel Bayamon, Inc., or (by March 1996) the US Forest Services Base Station in the El Yunque Rain Forest.

Table 1		
Places & Their Distance from Edison, New Jersey		
<u>Place Name</u>	<u>Miles</u>	<u>Kilometers</u>
Albany, New York	150	241.35
Binghamton, New York	135	217.22
Boston, Massachusetts	210	337.89
Buffalo, New York	300	482.70
Cape May, New Jersey	117	188.25
Corning, New York	182	292.84
Dunkirk, New York	290	466.61
Elmira, New York	167	268.70
Lake Placid, New York	260	418.34
Long Island, NY (eastern end)	135	217.22
Massena, New York	305	490.75
Montpelier, Vermont	274	440.87
Niagara Falls, New York	300	482.70
Old Forge, New York	223	358.81
Philadelphia, Pennsylvania	60	96.54
Pittsburgh, Pennsylvania	300	482.70
Plattsburgh, New York	292	469.83
Portland, Maine	300	482.70
Rochester New York	247	397.42
Syracuse, New York	200	321.80
Washington, D.C.	183	294.45
Watertown, New York	252	405.47
*Source: From AUTOMAP		

3.2 Mission Planning Software

The QUICK PLAN for Windows program can be used to provide projections of satellite visibility. The most important information provided by this software package is the number of visible satellites, the PDOP (how good the satellite geometry is), and the specific satellites that will be in view. These data are presented in a graphical manner for ease of use. Also useful, if you are having trouble receiving satellite signals, is a table that shows the azimuth and elevation of each

satellite. In order to accurately make correct forecasts of satellite availability, the program requires a recent ALMANAC.

Although an ALMANAC can conceivably be valid for up to three months, it is best to use the most recent one available, because older ALMANACS can provide erroneous information. An ALMANAC can be transferred from a remote receiver that was used in the field for over 15 minutes, or it can be found in any Base Station file. The GPS Coordinator can provide up to date information and advisories to field teams concerning satellite availability and any changes in GPS status.

3.3 GPS Equipment Requirements

The planning documents should be reviewed to ensure that GPS data is collected at appropriate times of the day. Plans must be made in advance to obtain and check out GPS equipment before going onto the field. The GPS equipment should be inventoried to ensure that all the parts are there, and batteries should be checked and recharged the day before going in the field.

The Pathfinder PRO XL's and XR's use two external lead acid camcorder batteries as a power source. Although recharging the lead acid batteries normally takes less than two hours, it is recommended that the lead acid batteries can remain on charge when not in use. The CMT MC-V Datalogger's Ni-Cd battery should only be charged when the battery level is 30%, or less. The Ni-Cd batteries must be fully recharged. This requires recharging the MC-V for 15 hours, but it should not be charged more than 16 hours. Overcharging the Ni-Cd batteries in the MC-V can reduce battery life and performance. The internal batteries in the MC-V (five Ni-Cd and one Lithium) are typically replaced every two years by the GPS Coordinator. The Trimble TDC1's are much more susceptible to losing stored data as there is no internal Ni-Cd battery available. Always keep the TDC1 attached to an external power source whether in the field or not. The TSC1 has an internal Lithium Ion which should be charged for 2 hours when it reads 30% or less. Additional charging will not damage the battery.

A checklist of items needed in the field can include; GPS equipment, a range pole, spare camcorder batteries, a backpack, a list of sites to be visited and directions to the sites, maps, QUICK PLAN satellite planning documents, a compass, a tape measure, and a field notebook. The GPS equipment should be tested prior to going in the field in order to ensure that it works properly and that field personnel adequately remember how to properly set up and use the equipment. The procedures specified in the document entitled "**Trimble Asset Surveyor Ver. 4.03 Ver. 4.03 Equipment Requirements**" should be followed to set the critical settings for the GPS equipment, and a sample locational data file should be collected.

3.4 Obtaining GPS Equipment

If you need to borrow GPS equipment from ESD you should contact the Regional GPS Coordinator (Michael Glogower) to determine if any units are available for loan. If the equipment is available, then a written request should be made to the Surveillance and Monitoring Branch Chief (Roland B. Hemmett), with a copy going to the Regional GPS Coordinator. The request should state why the equipment is needed, how many units will be requested, who will be using the equipment, and when it will be returned. In order to borrow ESD's GPS equipment the people that use the equipment should have taken the two day hands on GPS training course.

3.5 Performing the GPS Survey

The GPS equipment should be assembled at the site, making sure that the two external lead acid batteries are connected to the GPS receiver, the compact dome antenna is connected to the receiver, and that the MC-V Datalogger is connected to the receiver. The receiver should be turned on before use, since it takes a few minutes for the receiver to begin tracking the GPS satellites.

3.6 Critical Settings for Data Collection

Before the GPS unit is used to collect locational data there are several critical settings that must be checked (or set) at least once a day. Critical settings actually affect the quality and usability of the

GPS positions collected in the field. The procedures for assigning the proper critical settings are specified on page one of the document entitled "**Trimble Asset Surveyor Ver. 4.03 Ver. 4.03 Equipment Requirements**" (attached). Normally these settings remain in memory when the receiver and Datalogger are turned off, however, it is good practice to verify the critical settings once at the beginning of each day.

In addition to the critical settings, there are several non-critical settings, which affect the behavior of the software on the Datalogger (Asset Surveyor software), and display settings that affect how and in what format the information is displayed to the user, which should be checked or set. Instructions for selecting the non-critical settings are found on pages one and three of the "**Trimble Asset Surveyor Ver. 4.03 Equipment Requirements**", while the display settings are found on page two.

3.7 GPS Status Checks

Before beginning to collect a locational data file you must be certain that the GPS unit is receiving a current position fix. There are several ways to determine this. The fastest and easiest way to do this is to check the *Status Line* at the bottom of the screen on the Datalogger, which indicates the number of satellites being tracked and the PDOP. You need to be tracking at least four satellites (i.e. SV 4/7) to get a good (3-D) position and the PDOP must be below 6. When these conditions are met, then logging GPS data may begin. There may be times when obstructions, such as heavy tree cover, buildings, or topography do not allow the receiver to track four satellites with an acceptable PDOP. If the azimuths and elevations of these obstructions are known in advance this information can be incorporated into the planning software, and the times that GPS will work properly under those conditions can be generated. However, in most cases objects that block the receivers view to the satellites will be unanticipated, and will have to be dealt with in the field. There are several ways to get around this limitation, including;

The simplest way to handle this problem is to move the antenna slightly, by tilting your body, or move away from the point. However, if you move a significant distance from the point you want to locate you must measure (and record) the distance (in decimal feet or meters) from the point and azimuth (from true north) from the antennas actual location.

Waiting for the satellites to move into better positions. The positions of the satellites can be determined by using the Quick Plan printouts that provide information on where the satellites will be, in conjunction with a compass and a means to determine elevation.

Asset Surveyor comes with a built in offset feature that allows you to record the position of a point without actually being over that point. Offsets which are measured by using a compass and a tape measure, can be entered manually directly into the MC-V at the time of data collection.

3.8 Logging GPS Data

Once the Datalogger indicates that at least four satellites are being tracked, and that the PDOP is 6, or less, then the collection of locational data can begin. For a point location a minimum of 120 GPS positions should be logged on the Datalogger. While logging locational data field personnel can be taking pertinent notes and entering the relevant attribute information via the data dictionary in the Datalogger. A typical field data sheet is attached (Attachment # 2), includes an area to draw a diagram.

*** NOTE WHEN USING THE DATALOGGER'S KEYPAD TO ENTER IDENTIFICATION INFORMATION:** For those occasions where there is only facility or site level identification available, enter the number zero (0), for required sub-facility level fields if they exist in the data dictionary. When new/other entity level features are found, enter the word *new* in required fields that are of the character type, and 999 in required numeric fields.

Page four of the "**Trimble GPS Asset Surveyor Equipment Requirements**" document gives detailed instructions and step by step procedures to take to collect locational data. There are also

instructions for allowable file naming conventions that must be followed. Locational data files should be given names that mean something to the person that the data is being collected for.

After the locational data has been collected and the notes have been completed, the GPS equipment should be packed up. Be sure not to leave any equipment behind.

Upon returning to the office, field personnel shall make copies of the field notes, and give them along with the Datalogger, to the person that will transfer the locational data files into the Pathfinder Office software. The two lead acid camcorder batteries that were used should be recharged as soon as possible. They can remain on charge all the time. The GPS data files should be transferred from the Datalogger to a computer as soon as possible, in order to ensure that they are not accidentally lost or deleted.

Procedures are specified for transferring and backing up the files from the hand held data collector (a.k.a. Datalogger) to a computer on page five of the "**Trimble Asset Surveyor Ver. 4.03 Equipment Requirements**" document. The computer must be loaded with the Pathfinder Office Version 2.11 software. The software is needed to transfer the files from the hand held data collector to the PC and post processing. Procedures are also specified so that the locational data files are backed up to diskette (using the software). Once the files are transferred to the computer and backed up to diskette they should be deleted from the memory of the Datalogger. Files that are deleted from the hand held data collector are not recoverable.

3.9 Back at the Office

Remember to recharge two lead acid camcorder batteries, which can remain on charge all the time. Next, transfer the remotely collected locational data files from the MC-V to the PC. Step by step instructions are found on page five of the "**Trimble Asset Surveyor Ver. 4.03 Equipment Requirements**" document.

Postprocessing the GPS locational data files requires that appropriate Base Station files are obtained from a Community Base station, or from a second receiver (collecting in BASE mode) that is set over a point of known coordinates. Base Station files are collected in hourly file formats. EPA's hourly Base Station files can be obtained via a Bulletin Board Service (BBS) at (908) 321-6663. The hourly Base Station files are self extracting files that are named for the date and time that the data was logged. The format for these files is: **EYMMDDHH.EXE**

where:

E = stands for the EPA (Edison Community Base Station)

Y = stands for the last digit of the year (i.e. 1996, Y= 6)

MM = the month of the year (must use two digits, such as 02 for February)

DD = the day of the month (must use two digits, such as 01 for the first day of the month)

HH = the hour of the day in GPS time (this is equivalent to Greenwich Mean Time)

GPS Greenwich Mean Time Equivalency Table																								
HH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
EDT	8	9	10	11	MN	1	2	3	4	5	6	7	8	9	10	11	N	1	2	3	4	5	6	7
EST	7	8	9	10	11	MN	1	2	3	4	5	6	7	8	9	10	11	N	1	2	3	4	5	6

HH = the hour of the day in GPS time (this is equivalent to Greenwich Mean Time)

EDT = Eastern Daylight Savings Time (GMT minus 4 hrs = EDT)

EST = Eastern Standard Time (GMT minus 5 hrs = EST)

The Base Station files are collected in TRIMBLE's Standard Storage Format (SSF) and consequently are created with a three letter extension of **.SSF**. At five minutes after the hour the **.SSF** files are compressed and converted into a self-extracting file with a three letter extension of **.EXE**. For example, the hourly Base Station file of E6031519.SSF is collected on March 15, 1996 between two to three pm. At 3:05 pm this file is compressed and converted to a file named E6031519.EXE and is ready for downloading via the BBS. Since the Community Base Station generates a new base file for each hour, base files must be obtained for the period that corresponds to the time when the locational data was collected with the remote receivers. Base Station files from a Community Base Station automatically insert the correct location into the Base file. If another receiver is used as a Base Station then the correct coordinates may have to be entered into these files. This is done in the Pathfinder Office software, in the Reference Position sub-menu of the UTILITIES menu.

In order to differentially correct the locational data, it is normally more efficient to combine the Base Station files for the day into a single file. Before this can be done the Base files must be extracted from their compressed form into files with the **.SSF** extension. To self-extract the file(s) just type in the file name at the DOS prompt while your in the directory that contains the Base Station files. Then, get into the PathFinder Office software and select the appropriate Base Station file from the Combine SSF Files sub-menu of the UTILITIES menu. Make sure that the Sort Chronologically option is selected.

4. GPS Data Post Processing with Trimble's Pathfinder Office Software

4.1. Setting up the GPS Project Workspace

Creating a New Project

1. Run Pathfinder Office (PFO). Only once create a "New.." project for your GPS project, using the following steps:

- When the Select Project window first comes up, accept the "Default" project and hit "OK".
- From the File menu select *Projects*.
- In the Select Project window choose "New..".
- When the Projects Directories window comes up, enter a meaningful project name in the Project Name box. Remember, PFO will use the first 8 characters of the project name to create the top level directory for the project directory.
- In the "Project Folder" enter the path and directory name for the project if it does not already exist. If the directory already exists, you can use the "Browse" button to find this project directory.
- Hit "Enter"
 - In the Project Directory box, the top-level project directory now has been created in the directory path you provided. Three subdirectories will also be automatically created by Pathfinder Office; "export", "backup" and "base". We will not use these, at this level, but instead create another level of subdirectories when we download data.
 - If you browsed to an existing directory as the project directory you will be informed by PFO: "Folder already exists Do you want to continue?"

Choose use YES as PFO will only change it's pointer to existing directories.

2. When you are ready to download GPS data, you will need to add the next level of subdirectories, which is best organized by week. *The idea is to create a subdirectory to accomodate your data each time you do differential corrections. This will prevent your exported ArcView Shapefiles from being overwritten. If your GPS data collection project does not exceed one week then you do not need to add this next level of subdirectories.*

- The next level of subdirectories are added when you are ready to download GPS data. Use either the "Select Project" window, which is the first window to appear, or by accepting the settings in the Select Project window and using the "File" dropdown menu to select Projects.
- Click the *Modify* button in the Select Project window each time a new weekly subdirectory needs to be created. These weekly subdirectories will be the work place for receiving and differentially correcting the daily GPS files for that week. Clicking the *Modify* button will bring up the Project Directories menu.
- Click in the Project Directory box to change the daily subdirectory (week) name at the end of the project directory path.
- Of the 52 weeks in the year, choose the week number appropriate for this week's data collection by using the prefix "wk" followed by the week number, an underscore, and the last 2 digits of the year. (Your weekly subdirectory might appear as: **wk42_98**)
- Hit Return.
- Three (3) subdirectories (*export, backup, and base*), will be created under C:\<proj_name>\wk24_98.
- PFO will use the "export" subdirectory to receive the end results of the post processing which are ArcView (GIS) ShapeFiles in Geographic Projection and GPS metadata. (These products are the "deliverables" to be given to the Information Systems Branch for inclusion in our GIS database. Metadata includes the method accuracy and description (MAD) information describing the GPS data for the week, as well as GPS technical parameters.)
- Use the "backup" subdirectory to receive a backup of the GPS data downloaded from the data collector unit.
- PFO will use the "base" (for ex: wk42_98) subdirectory to receive the daily base station files required to correct the GPS data.

A project directory path for work downloaded on 10/16/98 should be:
C:\<proj_name>\wk42_98

3. After altering the weekly subdirectory part of the project directory path hit OK and you will be returned to the Select Project window. It can be seen, that 3 subdirectories under the daily directory were created: Export, Backup, and Base. Hit OK again. Now you can download each day's GPS files directly into the weekly subdirectory. You can then populate the "base", "backup" and "export" subdirectories as described above.

4.2 Downloading Rover Files

Download and backup on 3.5" disc, of each crew's GPS files (rover files), must be done at the end of every data collection day. When download to the appropriate daily subdirectory in Pathfinder Office and external 3.5" disc, is complete, check to see if the file can be opened in Pathfinder Office. If so, **then** delete the daily rover files on each data collector. This will prevent the possibility of opening the wrong daily data dictionary file during the next day's data capture.

1. Download:

1. Attach the Rover (GPS Data Logger) cable to the PC.
2. Turn the Rover ON.

3. On the Rover:
 - Press ESC when the it tries to read the number of satellites available.
 - On the Main Menu select File Transfer
4. Back on Pathfinder Office:
 - On the Utilities Menu select Data Transfer. A Data Transfer window will pop up.

Note: If the connection (to the Rover) fails, check the physical connections (cable) between the Rover and the PC. Check the Port dropdown list box in the upper right hand corner of the DataTransfer window, and choose the correct port.

5. On the Data Transfer window:
 - Device: GIS Data logger
 - Data Type: Data
 - Direction: Receive
 - Select the files to be downloaded from the Rover.
 - Click on Transfer (to actually start the data transfer)
 - Click on Disconnect to cancel the connection to Rover #1.

Note: If you disconnect the cable and don't click on Disconnect, PFO will think the first Rover is still connected (even if you connect a second Rover)

6. To connect a second Rover to the PC and download more data:
 - Physically disconnect the cable from Rover #1 after clicking on the Disconnect button.
 - Physically connect the next Rover to the PC.
 - Click on Connect (to establish communication between the PC and the Rover)

Note: Repeat the loop as many times as needed to download all the collected data from the Rovers (i.e different crews).

2. Backup Downloaded Data

1. Backup daily data onto labeled floppies (3.5").
2. Verify that the data (ALL) was actually backed up.

4.3 Downloading & Uncompressing Base Station Files

1. Download or Copy the base station files for the hours of GPS data collection, by all crews for that day, into the "Base" directory of the corresponding weekly subdirectory.

For example : C:\<proj_name>\wk42_98\base

2. Uncompress base station files (if needed). To uncompress the base files:

In Windows 3.x:

1. Program Manager: In the File Menu, select Run.
2. Type in the path and name of the compressed file (name.exe).

OR

In the File Manager: Go into the corresponding "Base" directory; double click on the file.

In DOS:

1. Change to the corresponding base directory (cd <DirectoryName>) where the base station file (.exe) is.
2. Type the name of the base station file (FileName.exe) and hit Enter.

In Windows 95/98

1. In the Start Menu, click on Run...
2. Type the path where the base station file is located. *For Example:*
C:\<proj_name>\wk42_98\base\basefile.exe

OR

In Windows Explorer: Go into the corresponding "Base" directory; double click on the file.

4.4 Differential Correction

****IMPORTANT:** Make sure you have already configured your copy of PathFinder Office to the required Region 2 GPS Program settings. To correctly configure Pathfinder Office, follow the directions in:

- Appendix 1: "Pathfinder Office (PFO) Coordinate System & Units Set Up" (to be done only once).
- Appendix 2: "Pathfinder Office EXPORT SETUP for ArcView ShapeFiles" (to be done only once).

To Differentially Correct your Rover (field collected) files:

Select **Utilities** from the menu bar

Select **Differential Correction**

- Rover Files: Select these files (*.ssf) by clicking on the Browse button.
- Base Files: Select these files by clicking on either :
 - Local Search (this searches your default Base folder)
 - Internet Search (searches from a list of Base Stations)
 - Browse (this searches your default Base folder)

Note: Verify that the Base File coverage is FULL.

- Corrected Files: These files will automatically go into the default output folder for the Project
- File Extension: *.cor

Processing: Select Code Processing Only

Click OK to exit the Differential Correction window

You should get a message saying: "100% of the selected positions were corrected". If this is not the case click on More Details to check which files had problems.

Quality Control (QC) Editing

After the *.ssf files have been differentially corrected you should open each file and edit it in order to maintain quality control over the collected data. Editing can improve the accuracy of point features by eliminating outlying positions from the averaged point coordinates. Editing should be done according to accuracy requirements of the project. The reduction in the spread of points is one of six GPS parameters used in the Region 2 GPS accuracy estimation. (See **Appendix 4: Region 2 GPS Accuracy Estimation.**) All Region 2 GPS data collections should strive for 5 meter accuracy. 120 pre-edited positions should be collected for point features with an accuracy requirement of 5 meters or better. Two (2) important things should be kept in mind when doing the QC editing, the standard deviation and the number of positions per point feature.

- In order to support 2 meter accuracy or better, a point feature must be edited when the Standard Deviation (SD) is greater than (>) 0.5 meters.
- A minimum of 90 net positions per point feature (after making any editing) are required in order to satisfy the position count requirement for both 1 and 2 meter accuracy. Less than 30 net positions will result in a "redo" accuracy assignment.

Quality Control Editing steps for points requiring 2 meter accuracy or better:

Under the "View" menu first choose *Map*, then *Time Line*. Arrange the windows.

In the "File" menu select Open. Select a corrected file by typing "*.cor" in the "Files of Type" window and choosing one from the current weekly workspace.

1. POINT Data :

Double click on the first point in the time line. The Feature Properties window will pop up. Click through the points using the > button on the Query Feature Window. Observe the Standard Deviation value of each point. Verify that the standard deviation (SD) is less than or equal to 0.5 meters. Edit the point if the SD is > 0.5 meter.

To edit the point:

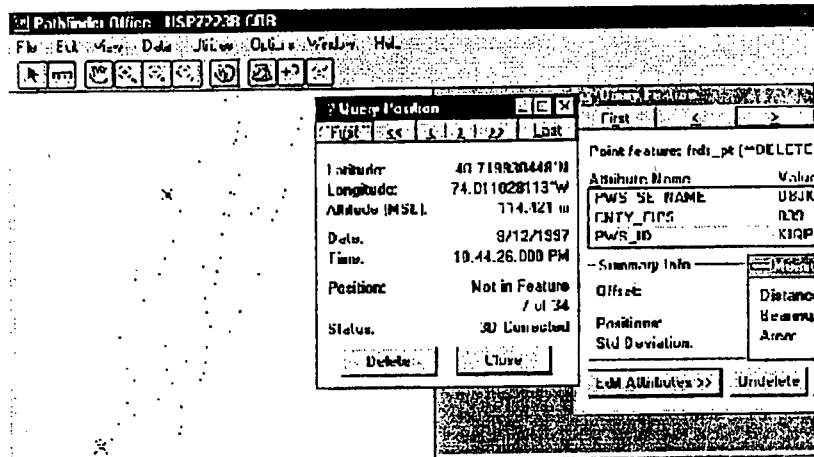
- In the map window zoom in on the desired point to about a 10 meter map extent.
- Positions (individual point fixes) from line and area features can be queried. Positions from point features cannot be queried, unless the point feature is first deleted (it can be undeleted afterwards). Click on Delete on the Feature Properties window
- A message saying : "Do you want to delete the current feature ?" will pop up. Click on Yes.
- Delete positions that are outliers. Also, use the field notes to determine which other positions need to be deleted.

Keep in mind that a minimum of 90 positions per point feature are needed for 2 meter accuracy.

- After editing, click on *Undelete* on the Feature Properties window to bring back the point feature you have edited. Often, the *Undelete* button in the Query Feature window will appear to have changed to *Delete*. This is because the focus for that window has accidentally changed to another point feature. Simply click through the points in the Feature Properties using the < or > keys until you find a point that has *Undelete*. Select *Undelete* to restore the point feature.
- Check the Standard Deviation (SD) again to see if it is now acceptable.
- Save the file and close it

- In the File Menu select **Save**, then

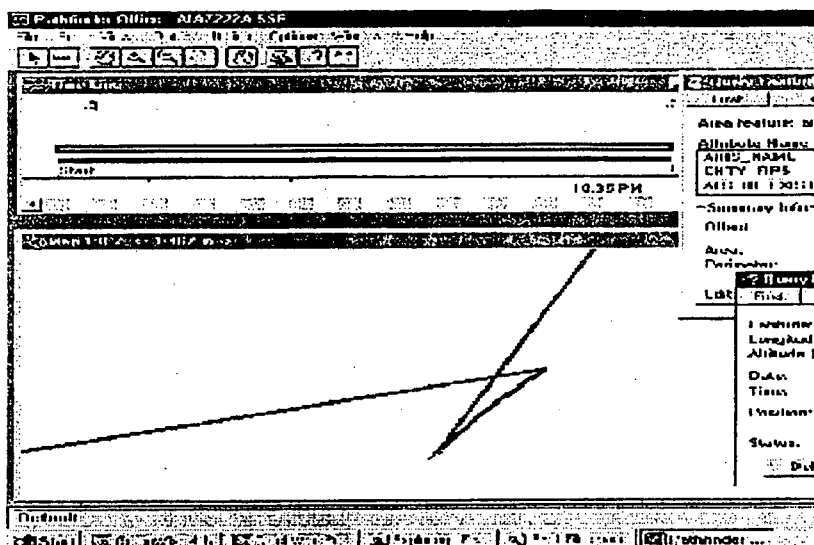
- In the File Menu select **Close**



2. POLYGON or AREA Data

GPS Areas should be acquired by taking 5 instantaneous positions at each vertices of the area perimeter. Each vertices must be captured in a regular sequence, (clockwise is preferable), along the perimeter. The last vertices taken can **not** also be the first. Area accuracy estimation (especially for small polygons) is much less reliable than point accuracy, and does not involve Standard Deviation.

- Open the corrected data dictionary file as described above
- Double click on the desired polygon (area) to be edited. The Feature Properties window will pop up - **Do not delete the polygon feature.**
- Open the Position Properties Window
- On the Map window, zoom into each of the vertices and using the *delete* option in the Position Properties window, delete those corner points that distort the shape of the polygon from how it appears in the field sketch. Leave one point for the corner that provides the truest shape to the polygon.
- Save and close the file as described above.



4.5 Loading the .cor Files for Export in Pathfinder Office

The .cor (differentially corrected) files also need to be loaded into the Export Utility of Pathfinder Office. We want to export ArcView ShapeFiles in the Geographic -WGS84 projection. To do this we only want to load .cor files that were produced from the same data dictionary. We do not want to load .cor files from different data dictionaries at the same time for Export. We need to run Export with the "R2 ArcView ShapeFile Geog-WGS84" format (see Appendix 2: **Pathfinder Office EXPORT SETUP for ArcView ShapeFiles** at end of document). This run will produce ArcView ShapeFiles. Pathfinder Office will send all exported data to the export subdirectory of the weekly directory.

- From the Utilities menu select Export. (An Export window will pop up.)
- In the Export window: Click on the Browse button.
- In the filename box of the Select Data File window type *.cor. Choose all of the cor. file(s) that share the same data dictionary suffix. **Files made with different data dictionaries can not be exported together.**
- Verify that the output directory is set up to the corresponding daily export sub directory.
- In the "Choose An Export Setup" area choose "R2 ArcView ShapeFile Geog-WGS84".
- Hit OK

5 GPS Data Management in ArcView GIS

The objective of a GPS data collection project should be to create a Locational Data Policy compliant GIS data layer for each GPS project feature. A GIS data layer and related database attributes can provide decision support for the investigation area. A GIS data layer is simply the merging of your daily GPS data (exported as ShapeFiles) into a project ShapeFile. There should be a data layer for each feature type you were acquiring GPS positions for. You will need to build your GIS data layer incrementally for longer term GPS projects or at the end of short term projects. This can be viewed as GPS data management in GIS. Region 2's GIS is ArcView.

EPA Region 2 staff, contractors and grantees, who are involved in GPS data collection efforts, can access an ArcView tool for GPS Data Management. The tool was designed to easily guide users through a sequence of processing steps to create Locational Data Policy (LDP) compliant GIS data layers from Trimble GPS ShapeFiles.

The Region 2 GPS Data Management Tool is an ArcView Extension that the user can load in ArcView by simply choosing the "Extensions" choice from the "File" drop-down menu in the ArcView Project Window.

Look for "Region 2 GPS Data Management Tool-Trimble". It is a good practice to load the extension right after you have chosen to open a new project in ArcView.

5.1 The Region 2 GPS Data Management Tool

The GPS Data Management Tool has the following capability:

1. Merges ArcView ShapeFiles while preserving all attribute fields in output. Source ShapeFiles are not changed. Single ShapeFiles will be reproduced in the same way but without merging.
2. Adds signed Latitude and Longitude attributes, (decimal degrees with 6 decimal digits), to ShapeFiles having Geographic Coordinates. Also checks for existing GPS related fields, and then adds additional, GPS metadata fields.
3. Estimates GPS accuracy.
4. Exports and Merges GPS metadata. When a user cycles through all 5 options under the "Make GPS Metadata" menu, the R2 GPS Data Management Tool insures that the ArcView ShapeFile output is a Locational Data Policy compliant GIS information layer. Each merged ShapeFile has an associated GPS metadata file created. These metadata files should be merged together as the last step. The user can then decide to use the tool's third menu "Project GPS" to create a copy of the output in the same projection as our Region 2 GIS Spatial Database.
5. Projects the output ShapeFile (which is in the Geographic coordinate system) into the user's choice of Puerto Rico State Plane or UTM Zone 18. There is no datum conversion capability. The datum is not changed from WGS84 and conforms to other Region 2 GIS layers in NAD83. There is a third 'Project GPS' choice for user defined input projections, (same datum), but since all GPS data will be exported only as Geographic WGS84 this choice won't be used for GPS data.

At the present time, in order to cycle through all 5 items under the "Make GPS Metadata" menu, your ArcView ShapeFiles must be created using Trimble's Pathfinder Office Ver. 2.11 software. This software is the differential correction software used to post process your Trimble GPS data.

The GPS Data Management tool takes the form of 3 menus in the View Window with drop-down selections (items). The three menus are:

1. "Merge GPS Shapes"
2. "Make GPS Metadata"
3. "Project GPS"

Users need only to step through these menus in sequence to process their GPS ShapeFiles (Geographic Coordinate System).

5.2 Procedures for Full Processing of GPS ArcView ShapeFiles Using the The Region 2 GPS Data Management Tool

It is important to remember to first bring all of the GPS ShapeFiles that you plan to process, into an ArcView project where the "Region 2 GPS Data Mgmt Tool-Trimble" extension has been loaded, before using the tool's menus. Make one view for each PFO "Export" directory being processed.

- 1. Bring all of your GPS ShapeFiles into one or more views in an ArcView project. In this project you will have enabled the "Region 2 GPS Data Mgmt. Tool-Trimble" extension. If the GPS data collection project was more than a short term effort, then the same feature type (i.e. ArcView theme or ShapeFile name) was probably exported at different times in the course of GPS data collection and post processing. In this case bring the ShapeFile(s) from each (weekly) "Export" subdirectory into a different view and use the pathname and ShapeFile directory as the View name. This can be done by copy & paste when you "Add Theme" in ArcView, and then choose "Properties" under the View menu. Now you can better determine if all of the data you want the tool to process has been brought into the ArcView Project. If you have only one exported ShapeFile or set of shape files from the GPS data collection, put this ShapeFile(s) into a single View.
- 2. Make a directory called "merge_geog". This directory will receive the processed ArcView Shapefiles. The Shapefiles will be in the same Geographic Projection as output from Pathfinder Office (PFO) and should be named the same also. Remember, your Shapefiles must be in Geographic Projection in order to use the Region 2 GPS Data Mgmt. Tool
- 3. When you have brought all your shape files in the project, open a new View. This will be your Region 2 Data Mgmt Tool workspace. Give this View the name "merge_geog". Choose the **'Find Themes to Merge'** selection from the **"Merge GPS Shapes"** menu. The first time you run this menu you will be prompted for the ArcView project workspace. Type or copy and paste the path and the directory called "merge_geog" into the window. Then make the View and Theme choices you are prompted for by the tool. If the tool brings back more than one theme into the workspace View, then choose the **"Merge Themes and Add To View"** option from the same menu. You should always give the merged theme the same name as the ShapeFile(s) exported from PFO. Repeat these steps until there are no more Themes presented to you in the List Message Box that prompts the user to: "Choose a Merge Theme that will be found in each of the Views you have chosen".
- 4. Now, when all shapes have been merged or duplicated in the workspace View, you can continue with the GPS Metadata processing loop by simply clicking the numbered (1 through 5) selections of the **"Make GPS Metadata"** menu. Each selection (1 through 5) of the "Make GPS Metadata" menu, needs only to be run once.
- 5. When finished you should merge the .dbf metadata files created for each of the merged ShapeFiles into a single metadata file. To do this use the **"Merge Metadata dbf's"** selection from the "Merge GPS Shapes" menu.

You can lastly choose the appropriate projection you would like to put your processed ShapeFiles in by using the **"Project GPS"** menu. This will allow you to view your GPS Data Layers on top of any Region 2 GIS Library layer in ArcView and use the Region 2 Environmental Cartography Kit to do spatial analysis. Before projecting your merged ShapeFiles you first need to create a directory in the ArcView project workspace named "merge_utm" or "merge_prsp" (for Puerto Rico State Plane). You will need to put your projected ShapeFiles into this sub-directory when prompted.

Region 2 GIS spatial data for New York and New Jersey is kept in the UTM - Zone18 (meters) projection, NAD83 datum. Region 2 GIS spatial data for Puerto Rico is kept in Puerto Rico State Plane (meters) projection, NAD83 datum.

The Region 2 GPS Data Management Tool can provide help for other tasks as well. Depending on their needs, users can use some menus items independently without cycling through all of the tool's menus. However, depending on the utility they require, they may have to follow an established sequence of menu choices.

For example a user can merge dBase (.dbf) files using the "Merge Metadata .dbf's" option under "Merge GPS Shapes" without following any menu sequence. In the same way a user can use any of the projection options under the "Project GPS" menu.

But if users want to merge non GPS ShapeFiles, they must start with the first option under "Merge

GPS Shapes" which is "Find Themes to Merge".

The GPS deliverables to Region 2 Information Systems Branch (ISB) for all Region 2 GPS data collection projects are the fully processed un-projected (i.e. Geographic Coordinate System) ArcView ShapeFiles and merged Metadata file output from the "Region 2 GPS Data Mgmt. Tool -Trimble".

Please Contact Bob Simpson - ISB at 212 637-3335 regarding these deliverables.

6. Appendices

Appendix 1: Pathfinder Office (PFO) Coordinate System & Units Set Up

Coordinate System's & Units Set Up in Pathfinder Office (PFO)

*Note: The settings described here need only to be set once.

A. Select **Options** from menu bar

- Select **Units**

- Distance: *meters*
- Area: *square kilometers*
- Velocity: *kilometers per hour*
- Offset: *meters**

*Note: The units for Offset are meters and it applies to the display and reporting of Offset and Standard Deviation data in Pathfinder office. It is important to make sure that the 'Offsets' field in the configuration menu for the data logger are set to meters and that GPS crews take offsets in meters.

- Offset Dist. format: *Slope distance and Inclination*
- Precisions: *Meters*
- Confidence: *68% Precisions*
- North Reference: *True*

Click Ok to exit Units

B. Select **Options** from menu bar

Select **Coordinate System**

- Select by: *Coord. System and Zone*
- System: *Latitude/Longitude*
- Datum: *WGS 1984*
- Altitude measured from: *Height Above Ellipsoid*
- Altitude units: *meters*

Click Ok to exit Coordinate System

C. Select **Utilities** from menu bar

Select **Differential Correction**

Click on **Settings** to configure the Differential Correction

On the Differential Correction Settings window:

- Select the **Output Tab**
 - Output Positions: *Corrected only*
 - Audit File Contents: *Standard*
- Select the **Base Options Tab**
 - Reference Confirmation: *Always required*
 - Filter minimums: Elevation: *0°* and SNR: *0*
- Select the **Code Processing Tab**
 - Rover Processing Technique: *Standard*
 - Correct Velocity Records: Keep it **UNCHECKED**
 - Correct Realtime DGPS Positions: **Keep it CHECKED**
 - Base Processing Technique: *Standard*
- Select the **Zipped Files Tab**
 - Keep all boxes **UNCHECKED**

Click Ok to exit Settings to return to the Differential Correction window

Appendix 2: Pathfinder Office EXPORT SETUP for ArcView ShapeFiles

Pathfinder Office EXPORT SETUP for ArcView Shapefiles

*Note: The settings described here need only to be set once.

Setting up the ArcView ShapeFile export format

1. Select *Utilities* from the menu bar.

- Select Export

- On the Export window:

In the 'Choose and Export Setup' area of the Export Window choose *Sample ArcView ShapeFile Setup* from the ones listed.

Create the Region 2 ArcView ShapeFile WGS84 Setup by clicking the *New Setup* button and then enter the name "*R2 ArcView ShapeFile WGS84*". Press **OK**

An *Export Setup* window will pop up with 6 tabs (Format, System, Attributes, Units, Coordinate System, and Position Filter) to be set up.

- On the **Format** tab:

-Format: *ArcView ShapeFile*

-Type of Data To Export: *Feature Positions and Attributes*

- On the **Systems** tab:

- System File Format: *DOS Files*

- On the **Attributes** tab

Export Menu Attributes As: *Attribute Value*

Generated Attributes:

For All Feature Types Check only the following:

PDOP

Correction Status

Date Recorded

Time Recorded

Feature Name

Data File Name

Total Positions

For Points:

Height

Standard Deviation

Horizontal Precision

For Lines:

Does not matter if no lines are collected.

For Areas:

Area

Perimeter

Worst Horizontal Precision

- On the **Units** tab

Units: *Use Export Units*

Distance: *meters*

Area: *Square kilometers*

Velocity: *Kilometers per hour*

- On the **Coordinate System** tab

Select "Use Export Coordinate System" and Click on the Change button. A Coordinate System window will pop up, set the following values:

Select By: *Coordinate System and Zone*

System: *Lat/Lon*

Datum: *WGS84*

Coordinate Units: (METERS will be grayed out)

Altitude Units: *Meters*

Altitude Measured From: *Height Above Ellipsoid (HAE)*

Click on the OK button

- On the **Position Filter** tab

Select the following values:

GPS Position Criteria: *Filter by GPS Position Info*

Minimum Satellites: *3D (4 or more SVs)*

Maximum PDOP: *Any*

Include Positions That Are:

Non GPS

P(Y) Code

Differentially Corrected

Realtime Differential

Phase Processed

Survey Grade

Appendix 3: Trimble PRO-XR w/TSCI & Asset Surveyor Requirements

July 28, 1999

PRO-XR w/ TSC1 & Asset Surveyor Ver 4.03 Requirements

Rover Settings (should be set/checked each day)

1. Turn the datalogger on by hitting the green key once, and allow it to boot up and perform a self check.

If you try to set the Critical Settings on the datalogger, without assembling the GPS unit, the unit tries to connect to the GPS system. After a minute, or so, the TSC1 will respond with a message stating "No GPS Detected", and it will ask if you want to retry now. Just hit the **F5** softkey for "**NO**" to enter the Main Menu. Short cut:: While the unit is searching for the GPS you can hit the **AEsc@** key to stop the unit from searching for the GPS (and enter the Main Menu).

2. From the Main Menu on a TSC1, use the arrow keys to highlight the Configuration Icon, then press the **AEnter@** key to enter the Configuration Menu (Short cut: or hit the letter **AC@** key on the keyboard).

3. Select "**GPS Rover options**" and press **AEnter@**.

4. Then select **ALogging options@** press **AEnter@**, and change the Rover settings to those listed below:

<u>Rover Options Setting Name</u>	<u>Recommended value</u>	<u>Comments</u>
Logging intervals:	1 second	If the logging interval is set incorrectly Asset Surveyor will not log data as often as you require, and may not log certain data at all. For Line or Area features you may want to use an interval of 3 seconds or 5 seconds
Point feature	1 second	
Line/Area feature	None	
Not in feature	None	
Velocity		
Confirm end feature	Yes	Insures that features are not ended unintentionally.
Minimum Positions	120 positions	100 positions plus 20 percent
Carrier phase	Off	This is not normally used.
Minimum time	10 Mins	
Dynamics code	Land	Choices are Land, Sea or Air .
Audible click	Yes	You want to hear this.
Log DOP data	Yes	This provides some of the QA/QC information.
Log PPRT data (VERY IMPORTANT)	Yes	This allows DGPS data to be Differentially Corrected (may result in better accuracy).
Hit the AEnter@ key to exit the Logging Options sub-menu.		
This returns you to the Configuration menu		

Next, in the Configuration menu, select the **APosition filters@** sub-menu and press **AEnter@**.

Position filters (sub-menu)

<u>Rover Options Setting Name</u>	<u>Recommended value</u>	<u>Comments</u>
Position mode	Manual 3D	At least four (4) satellites must be used.
Elevation mask	15 ° (for a rover)	Increase this by 1° for every 100 km (60 mi.) away from the Base.
SNR mask	8.0	Higher SNR=s provide better quality signals.
PDOP mask	6.0	PDOP's > 6.0 shut the receiver off. (Lower is better)
PDOP switch	6.0	Switches the receiver to 2D mode.
Apply real-time	Auto	Collects ALL corrected and uncorrected positions.
Hit the AEnter@ key to exit the APosition filters@ sub-menu.		

Next, in the Configuration menu, enter the **AAntenna options@** sub-menu.

<u>Rover Options Setting Name</u>	<u>Recommended value</u>	<u>Comments</u>
Height	0.000 m	Use only if you need to measure height accurately.
Measure	Vertical	
Confirm	Never	
Type	Integrated GPS/Beacon	
Part Number	29653-00	
Hit the AEnter@ key to exit the AAntenna options@ sub-menu.		

Almost done with the GPS rover options sub-menu.

Use the **AInitial Position@** sub-menu only if your more than 500 kilometers (300 miles) from the last location the GPS receiver was in. Call Mike Glogower for this information (732 321-6661).

Finally, we NEVER use the 2D altitude sub-menu.

Use the **AEsc@** key to return to the Configuration Menu.

We will skip over the **AGPS base station options@** since it is rarely used.

Next, select the **ACommunications options@**, and enter the Real-time input options.

<u>Rover Options Setting Name</u>	<u>Recommended value</u>	<u>Comments</u>
Radio type	Custom	
Baud rate	9600	Required for proper communication
Data Bits	8	A
Stop bits	1	A
Parity	None	A
RTCM options Station: Age limit:	Any 20s	Lets the GPS unit search for all available real-time correction sources. Tells the receiver how long to use an old correction.
Now use the AF1 softkey to enter the Integrated DGPS sub-menu (to set the Beacon settings)		
Source	Beacon	Lets the GPS unit search for Coast Guard Beacon(s).
Mode	Auto range	GPS will look for the closest Beacon.
Frequency	N/A	
<p>Hit the AEnter@ key to exit the Integrated DGPS@ sub-menu,</p> <p>then hit the AEnter@ key again to return to the ACommunications options@ sub-menu,</p> <p>We'll skip over the Realtime output options and the NMEA/TSIP output options sub-menus.</p> <p>and now hit the AEsc@ key to return to the AConfiguration@ menu.</p>		

Non Critical Display settings - change these to suit your own preferences:

If you're already in the Configuration Menu follow the directions in the Table below. If you're in the Main Menu on the TSC1 go to the Configuration menu.

<u>Setting or Menu names</u>	<u>Recommended values</u>	<u>Comments</u>
<u>Coordinate system</u> submenu		
Coordinate system	Select Latitude/Longitude and hit the AEnterAkey	
Datum:	WGS 1984	
Altitude units:	Meters (m)	
Altitude reference:	HAE	
Hit the AEnter@ key to exit the ACoordinate system@ sub-menu, and return to the AConfiguration@ menu.		
<u>Units and Display</u> submenu		
Units	Meters (m)	
Distance (2D):	Square Meters (m ²)	
Area:	Miles per hour	
Velocity:	Degrees (E)	
Angles:		
Angle format:	DD.MMSSss	
Order:	Lat/Lon (Latitude/Longitude)	
*North reference:	Magnetic	Use <u>Magnetic</u> to avoid setting the declination on the compass
*Magnetic declination	Automatic	
Null string:	?	
Language:	English	
Hit the AEnter@ key to exit the AUnits and display@ sub-menu, and return to the AConfiguration@ menu.		

* It is critical to set these items properly when using offsets*

We are still in the **Configuration** menu, now go to the **Time and date** submenu

<u>Setting or Menu names</u>	<u>Recommended values</u>	<u>Comments</u>
<u>Time and Date</u> submenu settings		
Time and date	Yes	Time and date submenu Once the receiver begins to operate these items will be automatically updated.
24-hour clock:	Reset it, if it's wrong	
Time:	MM/DD/YYYY	
Date format:	Reset it, if it's wrong	
Date:		
Hit the AEnter@ key to exit the ATime and date@ sub-menu, and return to the AConfiguration@ menu.		

External Sensor setup (Skip this step if you are NOT attaching an external sensor):

Scroll down to External Sensors and hit Enter, or hit the letter E on the keypad.

Scroll down to Laser and hit **Enter**. Make sure TYPE is set to the proper laser data format, (use Criterion 300 for the Geolaser), and set Auto Connect to Yes. Hit the **AEsc=@** key to exit this menu.

More Non-critical settings:

If you are still in the Configuration menu, hit the "H" key to get into the **Hardware** submenu (or use the arrow keys to highlight the Hardware submenu option, and then hit the **ENTER** key).

<u>Setting names</u>	<u>Recommended values</u>	<u>Comments</u>
<u>Hardware TSC1 submenu</u>		
LCD contrast:	45 %	On the TSC1 use the Fn and the E key to increase the contrast. and the Fn and the F key to decrease the contrast.
Backlight:	Off	On the TSC1 you can use the Fn and the L key to toggle this on and off.
Low voltage charging:	Off	
Auto shutoff	20 (minutes)	
Beep volume:	High	Volume of sounds made when data is logged.
Free Space		Space remaining on the dataloggers memory.
PC card free space	N/A	
Battery source:		Externals
Internal battery:	_____ %	Percent of battery power remaining. Recharge at 30%.
External battery:	_____ %	Percent of battery power remaining. Recharge every day.
Software version:	4.03	

Now, Hit the ESC Key to return to the Main Menu

ASSET SURVEYOR Operation - Use this procedure for collecting locational data.

- 1 - Assemble the instrument and turn on the datalogger while outside.
- 2 - Set/verify that **critical parameters** are properly set (Do this once a day).
- 3 - Wait a minute or two for the unit to "warm up". You know the unit is warmed up when there is a PDOP value displayed on the bottom line of the screen.
- 4 - From the Main Menu, enter the **Data collection** submenu.
- 5 - Hit **ENTER** on "Create rover file".
- 6 - *Name the file, and remember to write it down. Then hit the **ENTER**

key.

7 - Hit the arrow key to select the appropriate **Data Dictionary**.

8 - Hit the **Enter** key.

9 - Select the **Data Dictionary Feature** you are mapping and hit the **ENTER** key to start logging data

10 - Input the Data Dictionary information as required. Sometimes it's useful to hit the **F1** key for **PAUSE** before hitting the **ENTER** key so you don't log positions while entering in attributes. To remove **PAUSE** hit the **F1** key again for **RESUME**.

11 - When collecting point features keep the antenna stationary and collect a minimum of 120 positions. When collecting line or area features you must move the antenna along the feature. (eg. walking a trail, driving a road, or walking the perimeter of a building)

Note: - the **BOTTOM LINE** of this screen shows you the number of positions collected on the right

12 - If you can't get the antenna directly over the feature you can enter an **OFFSET** from the antenna location to the feature by hitting the **F3** key while logging point features, or the **F4** and **F2** key while logging line or area features. You will need to enter an **Azimuth** and **Distance** for point features, or a **Direction** and **Distance** for line and area features. Note, **Direction** is either **Right** or **Left** of the direction of travel and **Inclination** is usually **0E**. Be sure all information you enter matches the settings you put in under the **Units and Display** submenu in the **Configuration Menu**, and remember to make a sketch of what you did, in your notes.

13 - Once you have entered in the correct offset information hit the **Enter** key.

14 - Once you have collected enough positions, close the feature by hitting the **Enter** key. If you are going to collect another feature of the same type return to step 9 and repeat the process. If you are going to map a different kind of feature, or you are done for the day, continue to step

15 - Hit the **Esc** key on the TSC1, and a message will be displayed "**EXIT DATA COLLECTION?**", hit the **F1** key for **YES**.

16 - Now, you may return to Step 5 above, and repeat the procedure to log another file.

When you have finished logging data, and have closed the last data file, please shut off the datalogger by holding down the green ON/OFF key until the TSC1 shuts off.

*Allowable GPS File names

GPS unit letter, 2-Digit Month, 2-Digit Day, 3-Char. Data Dictionary

ZMMDD<dd>

Downloading GPS data to the PC:

To transfer files from the datalogger to the PC; bring up the PATHFINDER OFFICE program on the computer by double clicking on the PATHFINDER OFFICE icon from the Windows 95 desktop.

1. Set the correct Project Name for the data to be transferred into, or click on the New button to create a new project. If the project already exists, but needs to be modified click on the Modify button. You will need to modify an existing project if you are working on that project for more than one day. Enter a meaningful project name then edit the project directory line to include the date that you collected your data. For Example:

Project Collection date

C:\training\GPS week (i.e., WK42_98)

Make sure the Backup, Export, and Base subdirectories all say backup, export, and base respectively.

2. Click the OK button.
3. Hit the Enter key on the keyboard until the messages on the computer disappear.
4. Connect the datalogger to the PC.
5. Turn on the datalogger and get to the Main menu.
6. On the datalogger; hit the "F" key to enter the **File manager** menu (or use the arrow keys to highlight **File manager**, followed by the **Enter** key).
7. Go to **File transfer** and hit the **Enter** key. The message "connect cable to PC" will appear.
8. **Back to the PC**, click on the Utilities menu, then click on the Data Transfer option. If a connection is not made within a few seconds click on the Cancel button then change the Port in the data transfer box and click on the Connect button on the right side of the box.
9. Select the desired file(s) by double clicking on each file, or by clicking on the Add All button. Once you have picked all the files you want click on the Transfer button on the right side of the box.
10. After the files are transferred click on the X in the upper right corner of the data transfer box to close it. Then click on the X in the upper right corner of the screen to close the Pathfinder Office software.

To copy (backup) the files from the computer to Diskette using Windows 95 Explorer

(Note: If you're more comfortable using DOS commands, go for it).

1. You need to copy both the .SSF and the .blank file to the disk for backup before you erase the data off the datalogger.
2. To use the Windows 95 explorer to do this please refer to Chapter 5 of your GPS Training Manual for direction.
3. In the Windows 95 Explorer go to the backup directory of the collection date for your project, pick the files and copy them to the A: drive.
4. Check to make **sure that ALL** the files were copied by clicking on the A: drive to look on the disk.
5. **Now, return to the datalogger** and use the procedure below to **DELETE** all the files.
6. You should still be in **File manager**, so hit the "D" key (twice), or use the arrow keys to get to **Delete files**, and hit the **Enter** key.
7. Delete all files by hitting the **F5** key for **DelAll**. A message will appear asking "Do you want to delete all files?". Hit the **F1** key for **YES**.

8. Hit the **F1** key to confirm the deletion of the file.
9. Hit the **Enter** key to return to the Main Menu.
10. Hold down the green key shut the TSC1 off.

Remember to take GOOD NOTES; which include:



Date of collection for each file. GPS unit being used.

Name and address of location, and/or Site name.

The file name. The data dictionary being used.

The starting and ending times.

The number and type of feature inside the file.

A description of the locations (include a diagram/map with North arrow).

Charging Batteries (TSC1)

To check the status of the internal and external batteries, connect the external camcorder batteries to the receiver, and connect the receiver to the TSC1. Turn the TSC1 on and enter the Configuration menu. Now, hit the "H" key to access the HARDWARE submenu. Use the arrow keys to move down to the battery status screen. You must charge the internal batteries when it falls below the levels specified below. And recharge the two external camcorder batteries after each use.

Internal TSC1 Lithium-ion battery > 30 %

Two External Camcorder batteries > Recharge every day

GPS Receiver Battery (i.e. the Camcorder batteries)

These two batteries should be **charged after EACH USE**. Use both of the individual charging units to recharge the two 2.3 Amp-hour Camcorder batteries. Typical charging time is 2 - 4 hours for the Camcorder battery(s), but leaving these batteries in the charger longer is OK.

TSC1 Internal Battery:

A fully charged TSC1 battery will run off it's internal Lithium-ion battery for 7 hours (or more). The Lithium-ion battery **recharges in about three hours**. Recharge the TSC1 battery when its level drops to below 30 %.

EMERGENCY PROCEDURES (TSC1)

If you can't make the unit function properly, and you've checked the connections to the batteries and the antenna, you can try to use this procedure for a WARM BOOT.

WARM BOOT - does NOT erase data in memory.

1. Make sure the TSC1 is turned off. Then, hold down the Backspace key [Bksp] and press and release the Green ON/OFF key. If this fails, perform a Cold Boot.

COLD BOOT - WARNING THIS DOES ERASE ALL ENTRIES IN MEMORY

1. Make sure the TSC1 is turned off. Then, hold down the Fn key and the F5 key together.
2. While holding them down, press and release the Green ON/OFF key.
3. When the following message appears on the screen:

Force Reformat Internal Media

4. Release the Fn and F5. After a few minutes the program should start.

Finally, if nothing else works:..... you can always

Call Mike Glogower at (732) 321-6661; or,

call MAPCO (Mike Popoloski) at (973) 728-5767.

Appendix 4: Region 2 GPS Accuracy Estimation

Region 2's "ReturnTrimbleAccuracy" script uses ratios of horizontal 1dRMS error values to std_dev values. These ratios were estimated from Trimble's "Time Dependence of Averaging" test plots of horizontal Standard Deviation and horizontal RMS error as a function of occupation time (see "Characterizing Accuracy of Trimble Pathfinder Mapping Receivers by Grant Marshall of Trimble Navigation Limited Surveying and Mapping Systems Commercial Systems Group"). The ratio values are based on the Y value (cm of error or std_dev) at the intersection of the two curves. This equivalence value (49 cm of 1dRMS error or std_deviation) occurs at approximately 7.14 mins occupation time under optimum conditions and insignificant base2rover distance. Thereafter 1dRMS decreases and std_dev increases.

The Trimble graphs aim to characterize the time and distance dependence of accuracy (RMS error). Five 1dRMS-to-std_dev ratios for five occupation intervals (range is 0.5 mins to > 25 mins) are estimated by rsimpson using Trimble's graphed data for each of four base2rover distance intervals. Three additional equivalence points were also estimated based on 10cm of additional base2rover distance incurred error at 50km, 100km, and 150km base2rover. At 150km base2rover distance (an additional 30 cm of instantaneous RMS error) and 30 minutes occupation time, the curves are essentially asymptotic.

The time dependence effect, as estimated in the ratios, is presented as 5 "if..then" statements nested in 4 distance dependent "if..then" statements in the script. The std_dev value is multiplied by the appropriate ratio to estimate the 1dRMS error (intersection of curves) for that distance and occupation time. The product of "ratio * std_dev" for an occupation time interval at base2rover greater than 150 km is increased by 2ppm (10cm/50km) error $[(std_dev * ratio) + ((base2rover - 150000) * .000002)]$. The recalculated std_dev is added to Trimble's horiz_prec value as an estimate of the 2dRMS error. This estimated 2dRMS value is then multiplied by a Base station login interval coefficient and is the output estimated accuracy of the point. This value now reflects non zero mean noise, bias and blunders encountered under less than optimum conditions, as well as weak synchronicity in base and rover logging intervals.

It needs to be confirmed that the ratios should work for all Trimble receivers. The assumption is based on the fact that a "horiz_prec" value incorporates the specific 1dRMS error (which appears to be the instantaneous 1dRMS error) computed for each of Trimble's receivers. The behavior and relative values of the std_dev & RMS curves is also presumed to be the same at each model's different instantaneous 1dRMS value.

The 2dRMS estimate is conservative as Trimble's horiz_prec = $[(Receiver\ specific\ optimum\ 1dRMS\ value * average\ PDOP) + ((receiver\ specific\ ppm\ value\ (i.e\ PRO\ XL's = 1ppm)) * base2rover\ distance)]$. Also, the distance dependence of 1dRMS error for both the Trimble Pro XR and XL's is assigned a factor of 2 ppm in the script calculations.

MCORR400 is assumed to be the correction software.

Accuracy Estimation Parameters:

A. Points

theRecalStd_dev Val is based on ratios of horizontal 1dRMS error values to std_dev values. These ratios were estimated from Trimble's Time and Distance dependence of 1d RMS error (accuracy) test plots.

$$\text{theBaseloggin_factor} = (((\text{theBaselogginVal}/5).\text{Sqrt}).\text{Sqrt}).\text{Sqrt})$$
$$\text{Average Horizontal Precision} = [(\text{Receiver constant (error built into the receiver)}) * (\text{Average PDOP})] + [(\text{base2rover}) * \text{ppm}(\text{distance factor})]$$
$$\text{theMad_accurcVal} = ((\text{theHorz_precVal} + \text{theRecalStd_devVal}) * (\text{theBaseloggin_factor}))$$

B. Areas

$$\text{theBaseloggin_factor} = (((\text{theBaselogginVal}/5).\text{Sqrt}).\text{Sqrt}).\text{Sqrt})$$
$$\text{Worst Horizontal Precision} = [(\text{Receiver constant (error built into the receiver)}) * (\text{Worst PDOP})] + [(\text{base2rover}) * \text{ppm}(\text{distance factor})]$$
$$\text{theMad_accurcVal} = ((\text{theHorz_precVal} * 4) * (\text{theBaseloggin_factor}))$$

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APPENDIX D

USEPA REGION 2 DIVISION OF ENVIRONMENTAL SCIENCE AND ASSESSMENT: STANDARD OPERATING PROCEDURES FOR FIELD ACTIVITIES (excerpts)

**US EPA Region 2
Division of Environmental Science & Assessment
Monitoring & Assessment Branch**

**Standard Operating Procedures
for
Field Activities**



December 2006

U.S. Environmental Protection Agency
Region 2
2890 Woodbridge Avenue
Edison, New Jersey 08837

SECTION 14 SOIL SAMPLING

PERFORMANCE OBJECTIVES:

To collect a soil sample that is representative of conditions as they exist at the site:

- By selecting the appropriate sampling device(s);
- By taking measures to avoid introducing contamination as a result of poor sampling and/or handling technique;
- By reducing the potential of cross contamination between samples.

14.1 Introduction

Prior to conducting a soil sampling investigation, a sampling strategy should be developed based on the objectives of the investigation (Section 5.5 of this SOP contains a discussion of soil sampling strategies). After developing a soil sampling strategy, the appropriate equipment and techniques must be used to conduct the investigation. This section discusses the various soil sample collection methods, sample handling, and available sampling equipment which has been shown to be technically appropriate.

14.2 Equipment

Selection of equipment is usually based on the depth of the samples to be collected, but it is also controlled to a certain extent by the characteristics of the soil. Manual techniques and equipment such as hand augers are usually used for collecting surface or shallow, subsurface soil samples. Power operated equipment is usually associated with deep sampling, but can also be used for shallow sampling when the bore hole begins to collapse, or when the soil is so tight that manual sampling is not practical.

14.2.1 Precautions for Trace Pollutant Soil Sampling

All soil sampling equipment used for sampling trace pollutants should be constructed of inert materials, such as stainless steel, where possible. Pans used for mixing should be made of Pyrex® (or equivalent) glass. In no case will chromium, cadmium, galvanized, or plated equipment be used for soil sampling when trace levels of inorganic pollutants are of concern. Similarly, no painted or plastic equipment may be used where trace levels of organic pollutants are of concern. Paint, scale or heavy rust and grease must be removed before use, most often by sandblasting the equipment. Ancillary equipment such as auger flights may be constructed of other materials since this equipment does not come in direct contact with the samples. The procedures outlined in Section 5.11.7 should be followed.

14.3 Sampling Methodology

This discussion of soil sampling methods reflects both the equipment used to collect the sample

as well as how the sample is handled and processed after retrieval. Selection of equipment is usually based on the depth of sampling, but it is also controlled, to a certain extent, by the characteristics of the material. Simple, manual techniques and equipment, such as hand augers, are usually selected for surface, or shallow, subsurface soil sampling. As the depth of the sampling interval increases, some type of powered sampling equipment is usually needed to overcome the friction induced by soil resistance and depth. The following is an overview of the various sample collection methods employed over three general depth classifications: surface, shallow subsurface, and deep subsurface. Any of the deep collection methods described may be used to collect samples from the shallower intervals.

14.3.1 Manual Collection Techniques and Equipment

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. The shallow subsurface interval may be considered to extend from approximately 12 inches below ground surface to a site-specific depth at which sample collection using manual methods becomes impractical.

Surface Soils

Surface soils may be collected with a wide variety of equipment, if constructed of appropriate materials. Spoons or hand-augers are typically used to collect surface soil samples. If a thick, matted root zone is encountered at or near the surface, it should be removed before the sample is collected. The collected soil is placed in a pan, thoroughly mixed, (Section 5.11.8), and placed in the appropriate sample container(s). Section 13.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

Shallow Subsurface Soils

Hand augers are the most common equipment used to collect shallow subsurface samples. Typically, 4-inch auger-buckets with cutting heads are pushed and twisted into the ground, then removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand-auger depends upon the soil properties. In sand, auguring is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow back into the hole. At this depth, the bore hole will usually collapse and cannot be advanced. Deeper sampling must be accomplished using power equipment. Hand auguring may also be of limited use in tight clays or cemented sands. Regardless of the soil type, at depths approaching 20 feet sidewall friction may become so severe that power equipment must be used.

Power augers such as the Little Beaver® may be used to advance the borehole where hand augers are impractical. Power augers are a sampling aid, not a sampling device, and can be used to advance a borehole to approximately 20 feet, depending upon soil conditions. If power augers are used to advance the borehole, care must be taken that exhaust fumes, gasoline, and/or oil do not contaminate the borehole. The soil sample may then be collected using a hand auger. After the sample has been collected, the borehole may again be advanced (if necessary), and additional samples collected. The auger bucket must be replaced between samples with a properly decontaminated auger bucket. When a new borehole is advanced, the entire hand auger assembly must be replaced with a properly decontaminated hand auger assembly. If the borehole

is advanced using a hand auger, upon reaching the desired sampling depth replace the bucket with a properly decontaminated bucket. The sample may then be collected. After the sample has been collected, the borehole may be advanced (if necessary) with the bucket that was used to collect the sample. Each sample must be collected using a properly decontaminated bucket.

Before the soil is placed in a pan, it is necessary to remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, it is thoroughly mixed, (Section 5.11.8), and placed in the appropriate sample container(s). Section 13.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

14.3.2 Powered Equipment

Powered equipment may be used to acquire soil samples from any depth (surface, shallow subsurface, and deep subsurface). When power equipment is used to advance the borehole and collect the sample, care must be taken that exhaust fumes, gasoline, and/or oil do not contaminate the borehole and the sample. Among the common types of powered equipment used to collect subsurface soil samples are splitspoon samplers driven with a drill rig drive-weight assembly or pushed using drill rig hydraulics; continuous split-spoon samplers; direct-push rigs; and back-hoes. The Region 2 office does not own this type of equipment, however, contractors may be hired to perform work involving this equipment. Therefore, a brief description of this equipment is provided below.

Drill Rigs

Drill rigs offer the capability of collecting soil samples from greater depths. For all practical purposes, the depth of investigation achievable by this method is controlled only by the depth of soil overlying bedrock, which may be in excess of 100 feet.

Split-spoon samplers are usually driven either inside a hollow-stem auger or an open borehole after the auger(s) have been temporarily removed. The spoon is driven with a 140-pound hammer through a distance of up to 24 inches and removed.

Continuous split-spoon samplers may be used to obtain five-foot long, continuous samples approximately 3 to 5 inches in diameter. These devices are placed inside a five-foot section of hollow-stem auger and advanced with the auger during drilling. As the auger advances, the central core of soil moves into the sampler and is retained. Before the soil is placed in a pan, it is necessary to remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, it is thoroughly mixed, (Section 5.11.8), and placed in the appropriate sample container(s). Section 13.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

Direct Push Rigs

This method uses a standard split-spoon modified with a locking tip, which keeps the spoon closed during the sampling push. Upon arrival at the desired depth, the tip is remotely released and the push continued. During the push, the released tip moves freely inside of the spoon as the soil core displaces it. This technique is particularly beneficial at highly contaminated sites,

because no cuttings are produced. The push rods are generally retrieved with very little residue resulting in minimal exposure to sampling personnel and reduced IDW. Before the soil is placed in a pan, it is necessary to remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, it is thoroughly mixed (see Section 5.11.8), and placed in the appropriate sample container(s). Section 13.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

Geoprobe® Large Bore Soil Sampler

Geoprobe® offers several tools for soil sample collection. Among these are the Macro-Core® Soil Sampler and the large bore and dual tube soil sampling systems. The Branch does not have this equipment on hand, and therefore would need to hire a contractor to perform this work.

Back-Hoes

Back-hoes may be utilized in the collection of shallow subsurface soil samples. Samples may be collected directly from the bucket, or the trench wall (subject to applicable safety procedures). The bucket must be free of rust, grease, and paint. Only soil which has not been in contact with the bucket may be sampled, unless the bucket is cleaned according to the procedures described in Appendix B of this SOP.

Trenches offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. The sample should be collected without entering the trench itself, if possible. To collect the sample without entering the trench, use a stainless steel scoop attached to rigid conduit with a scoop bracket to "dress" the wall of the trench (by removing the surface layer of soil smeared on the trench wall as the bucket passed). Replace the scoop with a clean or decontaminated scoop, and then collect the soil sample. The collected soil is placed in a pan, thoroughly mixed, (see Section 5.11.8), and placed in the appropriate sample container(s). Section 13.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

14.4 Soil/Sediment Sampling (Method 5035)

The following sampling protocol is recommended for site investigators assessing the extent of volatile organic compounds (VOCs) in soils and sediments at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

14.4.1 Equipment

Soil/sediment for VOC analyses may be retrieved using the equipment specified in Section 13 of this SOP. Soil/sediment can be collected in either the EnCore™ VOC sampler, or using a stainless steel spatula and standard 4-oz. soil VOC container. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for the

site or sampling investigation. The various methods are described below.

14.4.2 Sampling Methodology - Low Concentrations

When total VOC concentrations in the soil/sediment are expected to be less than 200 ug/kg, the samples may be collected directly with the EnCore™ sampler. When sampling directly with the EnCore™ sampler, the vial must be immediately capped. A soil/sediment sample for VOC analysis may also be collected with conventional sampling equipment (as described in Section 13 of this SOP). A sample collected in this fashion must either be placed in the final sample container (EnCore™) immediately, or the sample may be immediately placed into an intermediate sample container with no head space. If an intermediate container (usually 4-oz. soil jar) is used, the sample must be transferred to the final sample container (EnCore™) as soon as possible, and should not to exceed 30 minutes.

NOTE: After collection of the sample into either the EnCore™ sampler or other container, the sample must immediately be stored in an ice chest and cooled. EnCore™ sampler soil/sediment samples may be prepared for shipping by capping, locking and securing the sampler in a plastic bag.

14.4.3 Sampling Methodology - High Concentrations

Based upon the data quality objectives and the detection level requirements, this high level method may also be used. Specifically, the sample may be packed into a single 4-oz. glass container with a screw cap and septum seal. The sample container must be filled quickly and completely to eliminate head space. Soils/sediments containing high total VOC concentrations may also be collected as described in Section 14.4.2, and preserved using 10 mL methanol.

14.4.4 Waste Samples

Collect an un-preserved sample into a single 4-oz. glass container. Handle waste samples in accordance with Section 15 of this SOP.

14.4.5 Special Techniques and Considerations

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size, sample representativeness for VOC's may be reduced compared to samples with larger volumes collected for other constituents. The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Sample holding times are specified in Appendix A. Field investigators should note that the holding time for an un-preserved VOC soil/sediment sample is 48 hours. Arrangements should

be made to ship the soil/sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

Percent Moisture

Samplers must ensure that the laboratory has sufficient material to determine percent moisture in the VOC soil/sediment sample to correct the analytical results to dry weight. If other analyses requiring percent moisture determination are being performed upon the sample, these results may be used. If not, a separate sample (minimum of 4-oz.) for percent moisture determination will be required.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Inhalation of methanol vapors must be avoided. Vials should be opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods, therefore shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. **The shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities.** A summary of the requirements for shipping samples follows. Refer to the CFR for a complete review of the requirements.

1. The maximum volume of methanol or sodium bisulfate in a sample container is limited to thirty (30) mls.
2. The sample container must not be full of methanol.
3. The sample container must be stored upright and have the lid held securely in place. Note that the mechanism used to hold the cap in place must be able to be completely removed so weight is not added to the sample container, as specified in Method 5035.
4. Sample containers must be packed in a sorbent material capable of absorbing spills from leaks or breakage of the sample containers.
5. The maximum sample shuttle weight must not exceed 64 pounds.
6. The maximum volume of methanol or sodium bisulfate per shipping container is 500

milliliters.

7. The shipper must mark the sample shuttle in accordance with shipping dangerous goods in acceptable quantities.

8. The package must not be opened or altered until no longer in commerce.

SECTION 6 GROUND WATER SAMPLING

PERFORMANCE OBJECTIVES:

- To collect a sample representative of ground water residing in the formation of interest.
- To reduce the potential bias caused by the sampling equipment used to obtain the sample.

In the late 1990's, EPA Region 2 approved a ground water sampling procedure using low stress purging and sampling techniques. This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II standard method for collecting groundwater samples from monitoring wells. This technique is used almost exclusively for Superfund work. Requests for the Monitoring and Assessment Branch to perform ground water sampling (under RCRA) has been a rare occurrence, and this is expected to continue. However, there may be some instances that MAB will be requested to sample ground water monitoring wells. In these instances, the low flow techniques specified in the Ground Water Sampling Procedure Using Low Stress Purging and Sampling Techniques (attached) will be followed. However, there will be some cases where low flow equipment and/or pumps cannot be used. In these cases the following procedures will be followed.

6.1 Introduction

Ground water sampling may be required for a variety of reasons, such as examining potable or industrial water supplies, checking for and/or tracking pollutant plume movement in the vicinity of a land disposal or spill site, Resource Conservation Recovery Act (RCRA) compliance monitoring, or examining a site where historical information is minimal or non-existent but where it is thought that ground water contamination may have occurred. Ground water samples are usually obtained from either temporarily, or permanently, installed ground water monitoring wells. They can also be obtained anywhere ground water is present, such as in a pit, or a dug hole, or drilled hole.

Occasionally, the ground water source may not be in the ideal location to meet a particular objective (e.g., to track a pollutant plume). In that case, either a temporary, or permanent, monitoring well should be installed. An experienced and knowledgeable person will need to locate the well and supervise its installation so that samples will be representative of the ground water. Additional guidance is given in RCRA Ground-Water Monitoring: Technical Guidance and Chapter 11 of SW-846. The ground water sampling procedures described in this SOP will meet or exceed the requirements of these documents.

Ground water sampling procedures can be sub-divided into two areas, purging and sampling, each of which has different goals and objectives. Within the topic of purging, it is necessary, because of the inherently different characteristics of the two types of wells, to address permanent and temporary wells separately. The procedures and techniques which follow in this section reflect these differences.

6.2 Purging

6.2.1 Purging and Purge Adequacy

Purging is the process of removing stagnant water from a monitoring well, immediately prior to sampling, causing its replacement by ground water from the adjacent formation, which is representative of actual aquifer conditions. In order to determine when a well has been adequately purged, field investigators should: 1) monitor the pH, specific conductance, temperature, and turbidity of the ground water removed during purging; and 2) observe and record the volume of water removed.

Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) should be determined. To do this, the diameter of the well should be determined and the water level and total depth of the well are measured and recorded. Specific methodology for obtaining these measurements is found in Section 16.3 of this SOP. Once this information is obtained, the volume of water to be purged can be determined using one of several methods. One is the equation:

$$V = 0.041 \times (d \times d) \times h$$

Where: h = depth of water in feet
 d = diameter of well in inches
 V = volume of water in gallons

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 6.1. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 6.1 which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well. Other acceptable methods include the use of nomographs, or other equations or formulae.

With respect to volume, an adequate purge is normally achieved when three to five times the volume of standing water in the well has been removed. The field notes should reflect the single well volume calculations, or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

With respect to the ground water chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the ground water have stabilized and the turbidity has either stabilized, or is below 10 Nephelometric Turbidity Units (NTUs) (twice the Primary Drinking Water Standard of 5 NTUs). Although 10 NTUs is normally considered the minimum goal for most ground water sampling objectives, one (1) NTU has been shown to be easily achievable and reasonable attempts should be made to reach this level. Stabilization occurs when pH measurements remain constant within 0.1 Standard Unit (SU), specific conductance varies no more than 10 percent, and the temperature is constant for at least three consecutive readings. There are no criteria establishing how many sets of measurements are adequate for the determination of stability. If the calculated purge volume is small, the measurements should be taken frequently to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes may be sufficient.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. If after five well volumes, pH and conductivity have been stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible. The conditions of sampling should be noted in the field log.

TABLE 6.1 WELL CASING DIAMETER vs. VOLUME	
WELL CASING DIAMETER(INCHES) vs. VOLUME (GALS.)/FEET of WATER	
CASING SIZE (in INCHES)	GALLONS/FT of WATER
1	0.041
2	0.163
3	0.367
4	0.653
5	1.020
6	1.469
7	1.999
8	2.611
9	3.305
10	4.080
11	4.934
12	5.875

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge, and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). It is not necessary that the well be evacuated three times before it is sampled. The pH, specific conductance, temperature, and turbidity should be measured, during collection of the sample from the recovered volume, as the measurements of record for the sampling event.

Attempts should be made to avoid purging wells to dryness. This can be accomplished, for example, by slowing the purge rate. If a well is pumped dry, it may result in the sample being comprised partially of water contained in the sand pack, which may be reflective, at least in part,

of initial stagnant conditions. In addition, as water re-enters a well that is in an evacuated condition, it may cascade down the sand pack or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column. It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered.

Equipment Available

Monitoring well purging is accomplished by using in-place plumbing and dedicated pumps or, by using portable pumps/equipment when dedicated systems are not present. The equipment may consist of a variety of pumps, including peristaltic, large and small diameter turbine (electric submersible), bladder, centrifugal, gear-driven positive displacement, or other appropriate pumps. The use of any of these pumps is usually a function of the depth of the well being sampled and the amount of water that is to be removed during purging. Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump should be used for purging. Appendix E of this SOP contains the operating instructions for all pumps commonly used during Section conducted ground water investigations.

Bailers may also be used for purging in appropriate situations, however, their use is discouraged. Bailers tend to disturb any sediment that may be present in the well, creating or increasing sample turbidity. If a bailer is used, it should be a bottom loading Teflon® bailer.

6.2.2 Purging Techniques (Wells Without Plumbing or In-Place Pumps)

For permanently installed wells, the depth of water and depth of the well should be determined (if possible) before purging. Electrical water level indicators/well sounders can be used for this purpose. It is standard practice to mark the top of casing, providing a point of reference from which these measurements will be consistently made. Field investigators should look for these markings when taking these measurements. Extreme caution should be exercised during this procedure to prevent cross-contamination of the wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. At a minimum, the well sounding device should be cleaned by washing in a laboratory detergent solution, followed by rinses with tap water and analyte-free water. After cleaning, it should be placed in a clean plastic bag or wrapped in foil.

Purging with Pumps

When peristaltic pumps or centrifugal pumps are used, only the intake line is placed into the water column. The line placed into the water should be either standard-cleaned (see Appendix B) Teflon® tubing, for peristaltic pumps, or standard-cleaned stainless steel pipe attached to a hose for centrifugal pumps.

When submersible pumps (bladder, turbine, displacement, etc.) are used, the pump itself is lowered into the water column. The pump must be cleaned as specified in Appendix B.

Purging with Bailers

Standard-cleaned (Appendix B) bottom loading Teflon® bailers with Teflon® leaders and new nylon rope are lowered into top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents. The use of bailers for purging and sampling is discouraged because the correct technique is highly operator dependent.

Field Care of Purging Equipment

Regardless of which method is used for purging, new plastic sheeting should be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they need to be placed on the ground during the purging or they accidentally come into contact with the ground surface. It is preferable that hoses used in purging that come into contact with the ground water be kept on a spool or contained in a plastic-lined tub, both during transporting and during field use, to further minimize contamination from the transporting vehicle or ground surface.

Purging Entire Water Column

The pump/hose assembly, or bailer, used in purging should be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed. If the pump is placed deep into the water column, the water above the pump may not be removed, and the subsequent samples, particularly if collected with a bailer, may not be representative of the ground water.

It is recommended that no more than three to five feet of hose be lowered into the water column. If the recovery rate of the well is faster than the pump rate and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the hose or pump will have to be lowered, as needed, to accommodate the draw down. After the hose or pump is removed from the well, all wetted portions of the hose and the pump should be cleaned as outlined in Appendix B of this SOP.

Careful consideration shall be given to using pumps to purge wells which are excessively contaminated with oily compounds, because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When wells of this type are encountered, alternative purging methods, such as bailers, should be considered.

General Low Flow/Low Stress Method Preference

The device with the lowest pump, or water removal rate, and the least tendency to stress the well during purging should be selected for use. For example, if a bailer and a peristaltic pump both work in a given situation, the pump should be selected because it will greatly minimize turbidity, providing a higher quality sample (Section 6.2.4 contains a description of low flow purging and sampling with a peristaltic pump used in a temporary well). If a Fultz® pump, or a Grundfos Redi-Flo2®, could both be used, the Redi-Flo2® may be given preference because the speed can

be controlled to provide a lower pump rate, thereby minimizing turbidity.

Low Flow/Low Volume Purging Techniques/Procedures

Alternatives to the low flow purging procedures exist and may be acceptable. The low flow/low volume purging is a procedure used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling, preferably, the zone with the highest flow rate. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours. Flow rates should not exceed the recharge rate of the aquifer. This is monitored by measuring the top of the water column with a water level recorder or similar device while pumping. These techniques, however, are only acceptable under certain hydraulic conditions and are not considered standard procedures.

6.2.3 Purging Techniques - Wells with In-Place Plumbing

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Many permanent monitoring wells at active facilities are also equipped with dedicated, in-place pumps. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a sample representative of the ground water. Among the types of wells identified in this section, two different approaches are necessary. The permanent monitoring wells with in-place pumps should, in all respects, be treated like the monitoring well without pumps. They generally are sampled only occasionally and require purging as described for wells without in-place pumps, i.e., 3 to 5 well volumes and stable parameters.

In the case of the other types of wells, however, not enough is generally known about the construction aspects of the wells to apply the same criteria as used for monitoring wells, i.e., removing 3 to 5 well volumes. The volume to be purged in these situations, therefore, depends on several factors: whether the pumps are running continuously or intermittently, and whether or not any storage/pressure tanks are located between the sampling point and the pump. The following considerations and procedures should be followed when purging wells with in-place plumbing under the conditions described.

Continuously Running Pumps

If the pump runs more or less continuously, no purge (other than opening a valve and allowing it to flush for a few minutes) is necessary. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance, temperature, and turbidity are recorded at the time of sampling.

Intermittently Running Pumps

If the pump runs intermittently, it is necessary to determine, if possible, the volume to be purged, including storage/pressure tanks that are located prior to the sampling location. The pump should then be run continuously until the required volume has been purged. If construction characteristics are not known, best judgement should be used in establishing how long to run the pump prior to collecting the sample. Generally, under these conditions, 30 minutes will be

adequate. Measurements of pH, specific conductance, temperature and turbidity should be made and recorded at intervals during the purge and the final measurements made at the time of sampling.

6.2.4 Purging Techniques - Temporary Monitoring Wells

Temporary ground water monitoring wells differ from permanent wells because temporary wells are installed in the ground water for immediate sample acquisition. Wells of this type may include standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as the Direct Push Wellpoint®, the Geoprobe® and the Hydropunch®. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply in these situations, because generally, stagnant water is non-existent. It is important to note, however, that the longer a temporary well is in place and not sampled, the more appropriate it may be to apply, to the extent possible, standard permanent monitoring well purging criteria to it.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity samples in these types of wells are typically and routinely achieved by the use of low-flow purging and sampling techniques.

The following low-flow purging technique using peristaltic pumps has been used routinely to achieve acceptably low NTU values in a variety of temporary monitoring well applications.

In purging situations where the elevation of the top of the water column is no greater than approximately 25 feet below the pump head elevation, a peristaltic pump may be used to purge temporary wells. Enough tubing is deployed to reach the bottom of the temporary well screen. At the onset of purging, the tubing is slowly lowered to the bottom of the screen and is used to remove any formation material which may have entered the well screen during installation. This is critical to ensuring rapid achievement of low turbidity conditions. After the formation material is removed from the bottom of the screen, the tubing is slowly raised through the water column to near the top of the column. The tubing can be held at this level to determine if the pump is lowering the water level in the well. If not, secure the tubing at the surface to maintain this pumping level.

If the water column is lowered, and the pump is not variable speed, continue to lower the tubing as the water column is lowered. If a variable speed peristaltic pump is being used and draw down is observed on initiation of pumping, reduce the pump speed and attempt to match the draw down of the well. Sustained pumping at these slow rates will usually result in a relatively clear, low turbidity sample. If the draw down stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated. In this case, the recovered water column may be relatively free of turbidity and can be sampled. It may take several episodes of recovery to provide enough volume for a complete sample.

With many of the direct push sampling techniques, purging is not practical, or possible, therefore, no purging is conducted. The sampling device is simply pushed to the desired depth and opened and the sample is collected and retrieved.

6.2.5 Investigation Derived Waste

Purging generates quantities of purge water or investigation derived waste (IDW), the disposition of which must be considered. What is appropriate for the disposition of the water is, in part, dependent on the nature of the investigation. If the IDW is generated at a RCRA facility, it will generally be contained and disposed on site in an on-site treatment facility. IDW generated during Superfund or other investigations may, at the discretion of the field project leader or the program manager (remedial project manager), be discharged to the ground, away from the well, or be containerized for later disposal, or other appropriate action.

6.3 Sampling

Sampling is the process of obtaining, containerizing, and preserving the ground water sample after the purging process is complete. Non-dedicated pumps for sample collection generally should not be used. Many pumps are made of materials, such as brass, plastic, rubber, or other elastomer products which may cause chemical interferences with the sample. Their principle of operation may also render them unacceptable as a sample collection device. The pump may be turbine driven, which may release volatile organic constituents. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

6.3.1 Equipment Available

Because of the problems with most pumps described in the preceding paragraph, only three devices should be used to collect ground water samples from most wells. These are the peristaltic pump, a stainless steel and Teflon® bladder pump, and a bottom loading Teflon® bailer.

Other monitoring equipment used during sampling includes water level indicators, pH meters, thermometers, conductivity meters, and nephelometers (turbidity meters).

6.3.2 Sampling Techniques - Wells With In-Place Plumbing

Samples should be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks that might be present. Remove any hose that may be present before sample collection and reduce the flow to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers (see Appendix A). It may be necessary to use a secondary container, such as a certified pre-cleaned 8 oz. sample jar, or a stainless steel scoop, to obtain and transfer samples from spigots with low ground clearance. Also, refer to the Potable Water Supply discussion in Section 2.2. All measurements for pH, specific conductance, temperature, and turbidity should be recorded at the time of measurement.

6.3.3 Sampling Techniques - Wells without Plumbing

Following purging, samples should be collected using a peristaltic pump, a Teflon®/stainless steel bladder pump, or a bottom loading Teflon® bailer. These techniques are described below.

Peristaltic pump

The peristaltic pump can be used for sample collection provided that a minimum length of pump tubing is used, and equipment blank samples are taken to verify if any contamination is caused by the sampling equipment. Use Teflon® tubing (¼-inch O.D.) to connect the pump tubing to the sample source, and an additional section of Teflon® tubing on the discharge side of the pump tubing. The pump creates a vacuum, and draws the sample into the sample container(s).

Samples for volatile organic compound analysis should be collected using a bailer, or by filling the Teflon® tube, by one of two methods, and allowing it to drain into the sample vials. The tubing can be momentarily attached to the pump to fill the tube with water. After the initial water is discharged through the pump head, the tubing is quickly removed from the pump and a gloved thumb placed on the tubing to stop the water from draining out. The tubing is then removed from the well and the water allowed to either gravity drain or be reversed, by the pump, into the sample vials. (Note: When reversing the pump, make sure the discharge tubing is not submerged in purge water. This will prevent introducing potentially cross contaminated purge water into the sample.) Alternatively, the tubing can be lowered into the well the desired depth and a gloved thumb placed over the end of the tubing. This method will capture the water contained in the tubing. It can then be removed from the well and the water collected by draining the contents of the tubing into the sample vials. Under no circumstances should the sample for volatile organic compound analysis be collected from the content of any other previously filled container. All equipment should be cleaned using the procedures described in Appendix B. Also, refer to the Potable Water Supply discussion, Section 2.2, for additional information. When sampling for metals only, it is also permissible to collect the sample directly from the pump discharge tubing after an adequate purge has been demonstrated. When collecting samples in this manner there are several considerations to be aware of. The pump head tubing (silastic, etc.) must be changed after each well and a rinsate blank must be collected of a representative piece of the pump head tubing (only one blank per investigation). Also, precautions must be taken to ensure that the end of the discharge tubing is not allowed to touch the ground or other surface to ensure the integrity of the sample collected in this manner.

Bladder Pumps

After purging has been accomplished with a bladder pump, the sample is obtained directly from the pump discharge. If the discharge rate of the pump, during purging, is too great, so as to make sample collection difficult, care should be taken to reduce the discharge rate at the onset of actual sample collection. This is necessary to minimize sample disturbance, particularly with respect to samples collected for the analysis of volatile organic compounds.

Bailers

When bailing, new plastic sheeting should be placed on the ground around each well to provide a clean working area. New nylon rope should be attached to the bailer via a Teflon® coated stainless steel wire. This coated wire is semi-permanently attached to the bailer and is decontaminated for reuse as the bailer is cleaned. The bailer should be gently immersed in the top of the water column until just filled. At this point, the bailer should be carefully removed and the contents emptied into the appropriate sample containers.

6.3.4 Sample Preservation

Immediately after collection, all samples requiring preservation must be preserved with the appropriate preservative. Consult Appendix A for the correct preservative for the particular analytes of interest. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample.

6.3.5 Special Sample Collection Procedures

Trace Organic Compounds and Metals

Special sample handling procedures should be instituted when trace pollutant samples are being collected. All sampling equipment, including pumps, bailers, water level measurement equipment, etc., which comes into contact with the water in the well must be cleaned in accordance with the cleaning procedures described in Appendix B. Pumps should not be used for sampling, unless the interior and exterior portions of the pump and the discharge hoses are thoroughly cleaned. Blank samples should be collected to determine the adequacy of cleaning prior to collection of any sample using a pump.

Order of Sampling with Respect to Analytes

In many situations when sampling permanent or temporary monitoring wells, an adequate purge, with respect to turbidity, is often difficult to achieve. Removal and insertion of equipment after the purge and prior to actual sampling may negate the low turbidities achieved during purging and elevate turbidity back to unacceptable levels. For this reason, it is important that special efforts be used to minimize any disturbance of the water column after purging and to collect the aliquot for metals first.

Filtering

As a standard practice, ground water samples will not be filtered for routine analysis. Filtering will usually only be performed to determine the fraction of major ions and trace metals passing the filter and used for flow system analysis and for the purpose of geochemical speciation modeling. Filtration is not allowed to correct for improperly designed or constructed monitoring wells, inappropriate sampling methods, or poor sampling technique.

When samples are collected for routine analyses and are filtered, such as under conditions of excessive turbidity, both filtered and non-filtered samples will be submitted for analyses. Samples for organic compounds analysis should not be filtered. Prior to filtration of the ground water sample for any reason other than geochemical speciation modeling, the following criteria must be demonstrated to justify the use of filtered samples for inorganic analysis:

1. The monitoring wells, whether temporary or permanent, have been properly constructed and developed.
2. The ground water samples were collected using sampling techniques in accordance with this section, and the samples were analyzed in accordance with EPA approved methods.

3. Efforts have been undertaken to minimize any persistent sample turbidity problems. These efforts may consist of the following:
 - Redevelopment or re-installation of permanent ground water monitoring wells.
 - Implementation of low flow/low stress purging and sampling techniques.
4. Turbidity measurements should be taken during purging and sampling to demonstrate stabilization, or the lack thereof. Measurements should be documented in the field notes.

If the ground water sample appears to have either a chemically-induced elevated turbidity, such as would occur with precipitate formation, or a naturally elevated colloid or fine, particulate related turbidity, filtration will not be allowed.

If filtration is necessary for purposes of geochemical modeling or other pre-approved cases, the following procedures are suggested:

1. Accomplish in-line filtration through the use of disposable, high capacity filter cartridges (barrel-type) or membrane filters in an in-line filter apparatus. The high capacity, barrel-type filter is preferred due to the higher surface area associated with this configuration. If a membrane filter is utilized, a minimum diameter of 142 mm is suggested.
2. Use a 5 μm pore-size filter for the purpose of determining the colloidal constituent concentrations. A 0.1 μm pore-size filter should be used to remove most non-dissolved particles.
3. Rinse the cartridge or barrel-type filter with 500 milliliters of the solute (ground water to be sampled) prior to collection of sample. If a membrane filter is used, rinse with 100 milliliters of solute prior to sample collection.

One blank sample should be taken per sampling event, prior to sample collection. Potential differences could result from variations in filtration procedures used to process water samples for the determination of trace element concentrations. A number of factors associated with filtration can substantially alter "dissolved" trace element concentrations; these include filter pore size, filter type, filter diameter, filtration method, volume of sample processed, suspended sediment concentration, suspended sediment grain-size distribution, concentration of colloids and colloidally associated trace elements, and concentration of organic matter. Therefore, consistency is critical in the comparison of short-term and long-term results. Further guidance on filtration may be obtained from the following: Metals in Ground Water: Sampling Artifacts and Reproducibility; Filtration of Ground Water Samples for Metals Analysis; and Ground Water Sampling - A Workshop Summary.

Bacterial Sampling

Whenever wells (normally potable wells) are sampled for bacteriological parameters, care must be taken to ensure the sterility of all sampling equipment and all other equipment entering the well. Further information regarding bacteriological sampling is available in the following: Sampling for Organic Chemicals and Microorganisms in the Subsurface; Handbook for Evaluating Water Bacteriological Laboratories; and Microbiological Methods for Monitoring the Environment, Water and Wastes.

6.3.6 Specific Sampling Equipment Quality Assurance Techniques

All equipment used to collect ground water samples shall be cleaned as outlined in Appendix B and repaired, if necessary, before being stored at the conclusion of field studies. Cleaning procedures utilized in the field (Appendix B), or field repairs shall be thoroughly documented in field records.

6.3.7 Auxiliary Data Collection

During ground water sample collection, it is important to record a variety of ground water related data. Included in the category of auxiliary data are water level measurements, well volume determinations, and pumping rates during purging. This information should be documented in the field records. Well volume determinations are described in Section 6.2.1.

6.4 Ground Water Level Measurements

6.4.1 Introduction

The measurement of the ground water level in a well is frequently conducted in conjunction with ground water sampling to determine the "free" water surface. This ground water level measurement can be used to establish ground water flow direction and gradients. Total well depth and ground water level measurements may be needed to determine the volume of water in the well casing prior to purging the well for sampling purposes.

All ground water level and total depth measurements should be made relative to an established reference point on the well casing and should be documented in the field records. To be useful for establishing ground water gradient, the reference point should be tied in with the NGVD (National Geodetic Vertical Datum) or a local datum. For an isolated group of wells, an arbitrary datum common to all wells in that group may be used, if necessary.

6.4.2 Specific Ground Water Level Measuring Techniques

Measuring the depth to the free ground water surface can be accomplished by the following methods:

1. Electronic Water Level Indicators - This instrument consists of a spool of dual conductor wire, a probe attached to the end, and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or buzzer attached to the spool will signal the contact. Penlight or 9-volt batteries are normally used as a power source. Measurements should be made and recorded to the nearest 0.01 foot.
2. Interface Probe - This instrument is used if a light non-aqueous phase liquid (LNAPL) such as oil is floating on the surface of the ground water. When the probe comes in contact with the LNAPL, a continuous beeping sound is emitted. As the probe is lowered through the layer of LNAPL, it eventually comes in contact with the ground water surface and an intermittent beeping sound is emitted. By subtracting the depth to the LNAPL from the depth of the ground

water, the thickness of the LNAPL layer is calculated.

3. **Weighted Tape** - In this method a suitable weight, is used to suspend the tape. The weight should, ideally, be made of a relatively inert material and should be easily cleaned. Measurements should be made and recorded to the nearest 0.1 foot.
4. **Chalked Tape** - Chalk rubbed on a weighted steel tape will discolor or be removed when in contact with water. Distance to the water surface can be obtained by subtracting the wet chalked length from the total measured length. The tape should be withdrawn quickly from the well because water has a tendency to rise up the chalk due to capillary action. Measurements should be made and recorded to the nearest 0.01 foot. This method is not recommended if samples are to be collected for analyses of organic or inorganic pollutants.
5. **Other Methods** - There are other types of water level indicators and recorders available on the market such as the sliding float method, air line pressure method, and electrical and automatic recording methods. These methods are primarily used for closed systems or permanent monitoring wells. Acoustic water level indicators are also available which measure water levels based on the measured return of an emitted acoustical impulse. Accuracies for these methods vary and should be evaluated before selection. Any method not capable of providing measurements to within 0.1 foot should not be used.

6.4.3 Total Well Depth Measurement Techniques

The weighted tape, or electronic water level indicators can be used to determine the total well depth. This is accomplished by lowering the tape or cable until the weighted end is felt resting on the bottom of the well. Because of tape buoyancy and weight effects encountered in deep wells with long water columns, it may be difficult to determine when the tape end is touching the bottom of the well. Care must be taken in these situations to ensure accurate measurements. All total well depth measurements must be made and recorded to the nearest 0.1 foot.

6.4.4 Equipment Available

The following equipment is available for ground water level and total well depth measurements:

1. weighted steel measuring tapes
2. electronic water level indicators.

6.4.5 Specific Quality Control Procedures

Before each use, these devices should be prepared according to the manufacturer's instructions (if appropriate) and checked for obvious damage. These devices should be decontaminated according to the procedures specified in Appendix B prior to use at the next well. All maintenance data should be recorded in a logbook.

6.4.6 Well Pumping Rate - Bucket/Stop Watch Method

The pumping rate for a pump can be determined by collecting the discharge from the pump in a bucket of known volume and timing how long it takes to fill the bucket. The pumping rate should be in gallons per minute. This method shall be used primarily with pumps with a constant pump rate, such as gasoline-powered or electric submersible pumps. Care should be taken when using this method with some battery-powered pumps. As the batteries' charge decreases, the pump rate also decreases so that pumping rate calculations using initial pump rates may be erroneously high. If this method is used with battery powered pumps, the rate should be re-checked frequently to ensure accuracy of the pumping rate calculations.

6.4

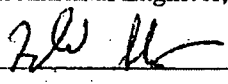
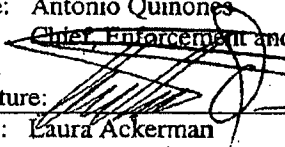
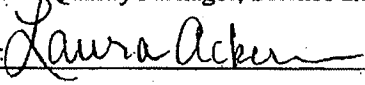
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APPENDIX E

USEPA REGION 4 SCIENCE AND ECOSYSTEM SUPPORT DIVISION: OPERATING PROCEDURE FOR SOIL SAMPLING (excerpts)

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Region 4 U.S. Environmental Protection Agency Science and Ecosystem Support Division Athens, Georgia	
OPERATING PROCEDURE	
Title: Soil Sampling	
Effective Date: November 1, 2007	Number: SESDPROC-300-R1
Authors	
Name: Fred Sloan Title: Environmental Engineer, Regional Expert	
Signature: 	Date: 11/2/07
Approvals	
Name: Antonio Quinones Title: Chief, Enforcement and Investigations Branch	
Signature: 	Date: 11/02/07
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Signature: 	Date: 11/01/07

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
<p>SESDPROC-300-R1, <i>Soil Sampling</i>, replaces SESDPROC-300-R0.</p> <p>General Corrected any typographical, grammatical and/or editorial errors.</p> <p>Title Page Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch.</p> <p>Section 1.3 Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities.</p> <p>Section 1.4 Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency.</p> <p>Section 1.5.1 Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.</p> <p>Section 1.5.2, 4th bullet Added references to the CFR and IATA's Dangerous Goods Regulations.</p> <p>Section 2.7 Updated referenced operating procedures due to changes in title names.</p>	November 1, 2007
SESDPROC-300-R0, <i>Soil Sampling</i> , Original Issue	February 05, 2007

4.4 Dual Tube Soil Sampling System

The Dual Tube 21 soil sampling system is a direct push system for collecting continuous core samples of unconsolidated materials from within a sealed outer casing of 2.125-inch (54 mm) OD probe rod. The samples are collected within a liner that is threaded onto the leading end of a string of 1.0-inch diameter probe rod. Collected samples have a volume of up to 800 ml in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core. Use of this method allows for collection of continuous core inside a cased hole, minimizing or preventing cross-contamination between different intervals during sample collection. The outer casing is advanced, one core length at a time, with only the inner probe rod and core being removed and replaced between samples. If the sampling zone of interest begins at some depth below ground surface, a solid drive tip must be used to drive the dual tube assembly and core to its initial sample depth.

4.5 Special Considerations When Using Direct Push Sampling Methods

- *Liner Use and Material Selection* – Due to the mode of operation, the samples must be collected with a liner. Liners are available in the following materials: stainless steel, brass, cellulose acetate butyrate (CAB), PETG, polyvinyl chloride (PVC) and Teflon®. For the majority of environmental investigations conducted by EIB, either CAB or Teflon® liners are used. If samples are collected for organic compound analyses, Teflon® liners are required. CAB or PVC liners may be used if metals or other inorganic constituents are the object of the investigation.
- *Sample Orientation* – When the liners and associated sample are removed from the sample tubes, it is important to maintain the proper orientation of the sample. This is particularly important when multiple sample depths are collected from the same push. It is also important to maintain proper orientation to define precisely the depth at which an aliquot was collected. Maintaining proper orientation is typically accomplished using vinyl end caps. Convention is to place red caps on the top of the liner and black caps on the bottom to maintain proper sample orientation. Orientation can also be indicated by marking on the exterior of the liner with a permanent marker.
- *Core Catchers* – Occasionally the material being sampled lacks cohesiveness and is subject to crumbling and falling out of the sample liner. In cases such as these, the use of core catchers on the leading end of the sampler may help retain the sample until it is retrieved to the surface. Materials of construction for core catchers must be consistent with the type of liner used, i.e., if stainless steel liners are required, stainless steel core catchers must be used.
- *VOC Sample Collection* - Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

APPENDIX F

**ASTM STANDARD D 6418-04: STANDARD PRACTICE FOR USING THE
DISPOSABLE EN COREJ SAMPLER FOR SAMPLING AND STORING SOIL FOR
VOLATILE ORGANIC ANALYSIS (excerpts)**



Designation: D 6418 – 04

Standard Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil for Volatile Organic Analysis¹

This standard is issued under the fixed designation D 6418; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice is intended for application to soils that may contain volatile waste constituents.

1.2 This practice provides a procedure for using the disposable En Core² sampler to collect and store a soil sample for volatile organic analysis.

1.3 It is recommended that this standard be used in conjunction with Guide D 4547 and Guide D 4687.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

Note 1—ASTM takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

2. Referenced Documents

2.1 ASTM Standards:³

D 2777 Practice for Determination of Precision and Bias of Applicable Methods of Committee D-19 on Water

D 4547 Guide for Sampling Waste and Soils for Volatile Organics

D 4687 Guide for General Planning of Waste Sampling

D 5792 Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives

¹ This practice is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.03 on Sampling Equipment.

Current edition approved Feb. 1, 2004. Published April 2004. Originally approved in 1999 as D 6418 – 99. Last previous edition approved in 2003 as D 6418 – 03.

² En Core is a registered trademark of En Novative Technologies, Inc., Green Bay, WI. The En Core sampler is covered by a patent. Interested parties are invited to submit information regarding the identification of an alternative(s) to this patented item to the ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Summary of Practice

3.1 This practice provides a procedure for using the disposable En Core sampler to collect and store a soil sample of approximately 5 or 25 g for volatile organic analysis. The En Core sampler, which consists of a coring body/storage chamber, O-ring sealed plunger, and O-ring sealed cap, is designed to collect and hold a soil sample during shipment to the laboratory for analysis.

3.2 After the sample is collected in the En Core sampler, the coring body/storage chamber is sealed with a slide-on cap and immediately becomes a sample storage chamber. To minimize loss of volatile compounds due to volatilization, or biodegradation, or both, from the time of collection until analysis or chemical preservation in the laboratory (see Guide D 4547), sample storage options are specified at $4 \pm 2^\circ\text{C}$ for up to 48 h; at -7 to -21°C for up to 14 days; or at $4 \pm 2^\circ\text{C}$ for up to 48 h followed by storage at -7 to -21°C for up to five days (see Appendix X1 and reports referenced in footnotes 4, 5, and 6 for information on the performance of the En Core sampler under these storage conditions).^{4,5,6} Storage of samples in the En Core sampler at $4 \pm 2^\circ\text{C}$ or -7 to -21°C for longer holding times than those listed above is an option, provided it can be shown that the longer storage time used does not influence the concentrations of the volatile organic compounds (VOCs) of interest in the samples, or that the data generated by analysis of the samples meet the data quality objectives (DQOs) (see Practice D 5792). This practice does not use methanol preservation or other chemical preservatives in the field.

4. Significance and Use

4.1 This practice is for use in collecting and storing 5- or 25-g soil samples for volatile organic analysis in a manner that minimizes loss of contaminants due to volatilization, or biodegradation, or both. The En Core sampler serves as both the sampling device and sample storage chamber.

⁴ Hewitt, A. D., Frozen Storage of Soil Samples for Volatile Organic Compound Analysis, *Environmental Testing and Analysis*, Vol. 8, No. 5, 1999, pp. 18–25.

⁵ A copy of the research report describing the study performed to evaluate the precision of the En Core sampler to store low VOC concentrations is available from ASTM Headquarters, Request RR: D34-1014.

⁶ A copy of the research report describing the study performed to evaluate the performance of the En Core sampler at $-7 \pm 1^\circ\text{C}$ and $-21 \pm 2^\circ\text{C}$ is available from ASTM Headquarters, Request RR: D34-1015.

4.2 In performing the practice, the integrity of the soil sample structure is maintained during sample collection, storage, and transfer in the laboratory for analysis or preservation.

4.3 During sample collection, storage, and transfer, there is very limited exposure of the sample to the atmosphere.

4.4 Laboratory subsampling is not required when performing this practice. The sample is expelled directly from the coring body/storage chamber into the appropriate container for analysis or preservation without disrupting the integrity of the sample. Subsampling from the En Core device should not be performed to obtain smaller sample sizes for analysis.

4.5 This practice specifies sample storage in the En Core sampler at $4 \pm 2^\circ\text{C}$ for up to 48 h; at -7 to -21°C for up to 14 days; or at $4 \pm 2^\circ\text{C}$ for up to 48 h followed by storage at -7 to -21°C for up to five days (see Appendix X1 and reports referenced in footnotes 4, 5, and 6 for information on the performance of the En Core sampler under these storage conditions).^{4,5,6} Storage of samples in the En Core sampler at $4 \pm 2^\circ\text{C}$ or -7 to -21°C for longer holding times than those listed above is an option, provided it can be shown that the longer storage time used does not influence the concentrations of the VOCs of interest in the samples, or that the data generated by analysis of the samples meet the DQOs (see Practice D 5792).

4.6 This practice does not use methanol preservation or other chemical preservatives in the field. As a result, there are no problems associated with flammability hazards, shipping

restrictions, or dilution of samples containing low volatile concentrations due to solvents being added to samples in the field.

4.7 The En Core sampler is a single-use device. It should not be cleaned, or reused, or both.

4.8 This practice cannot be used for sampling cemented material, consolidated material, or material having fragments coarse enough to interfere with proper coring techniques.

5. Apparatus

5.1 *En Core Sampler*—The En Core sampler has three components: the coring body/storage chamber, which is volumetrically designed to collect and store a soil sample of approximately 5 or 25 g; an O-ring sealed plunger for nondisruptive extrusion of the sample into an appropriate container for analysis or preservation; and, a slide-on cap having an O-ring seal and locking arm mechanism (see Fig. 1). The coring body/storage chamber of the 5-g sampler has a volume of 3 cm^3 to give a sample size of approximately 5 g, assuming a soil density of 1.7 g/cm^3 . The coring body/storage chamber of the 25-g sampler has a volume of 14.5 cm^3 to give a sample size of approximately 25 g, assuming a soil density of 1.7 g/cm^3 . The seals of the sampler are provided by three polytetrafluoroethylene-coated fluoroelastomer O-rings (see Fig. 1). The coring body/storage chamber, plunger, and cap of the En Core sampler are constructed of an inert composite polymer. The En Core sampler is certified as clean and should

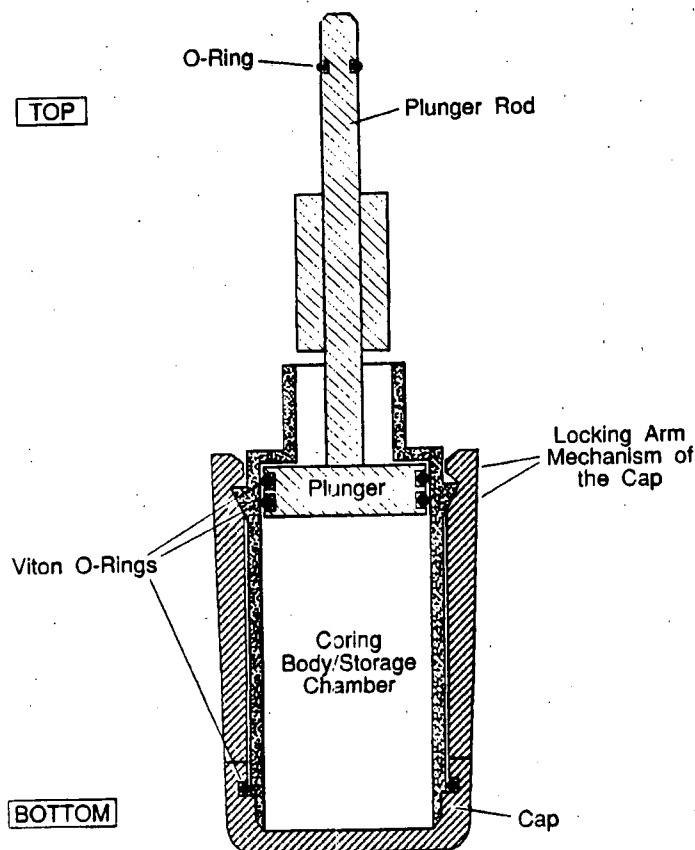


FIG. 1 Components of the En Core Sampler

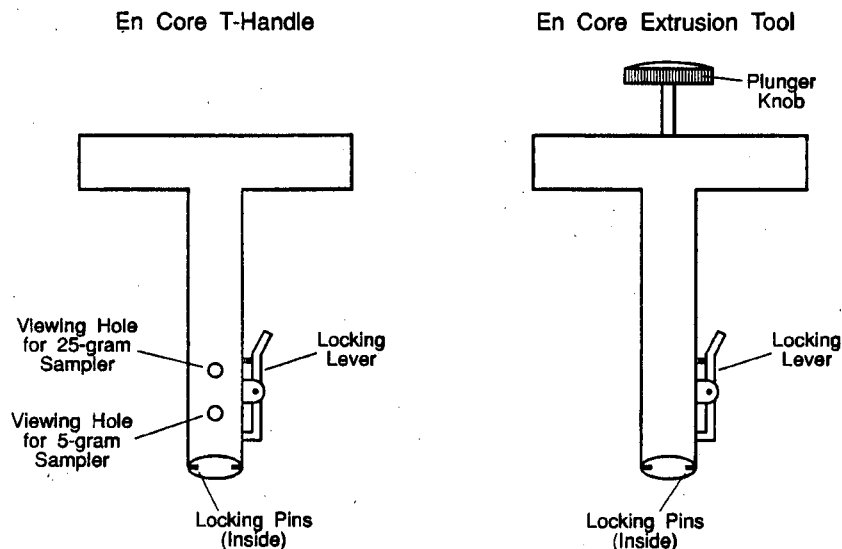


FIG. 2 Reusable Attachments to the En Core Sampler

not be reused. There are two stainless steel reusable attachments that are used with the En Core sampler. These are a T-handle, which is used to push the sampler into the soil for sample collection; and an extrusion tool, which attaches to the plunger for extrusion of the sample from the coring body/storage chamber (see Fig. 2). Each En Core sampler is supplied with a protective moisture-proof bag for shipment to the laboratory.

5.2 Cooler with ice or cold packs, or refrigerated compartment regulated at $4 \pm 2^\circ\text{C}$ and/or a freezer compartment regulated at a temperature within the range of -7 to -21°C .

5.3 *Minimum/Maximum Temperature Monitor*—This is any device that registers the minimum and maximum temperatures reached during a given period of time in $^\circ\text{C}$ and has a range that includes the specified storage temperature in divisions of 1°C , such as a minimum/maximum thermometer or temperature data logger.

6. Procedure

6.1 The size of the En Core sampler used is determined by the size of the sample required by the laboratory procedure that will be used to analyze the sample. If a sample size of approximately 5 g is required for analysis, the 5-g En Core sampler, and not the 25-g device, should be used to collect and store the sample. Subsampling from the En Core devices should not be performed to obtain smaller sample sizes for analysis.

6.2 If volatile contaminant levels in the soil being sampled are not known, it is recommended that three samples be collected at each sampling location using three En Core samplers. If determination of moisture content is required for reporting sample results on a dry weight basis, a fourth sample should be collected from each sampling location using a suitable container. The proper sample preparation method for

low-level or high-level volatile analysis^{7,8} can be determined by screening one of the three samples collected in the En Core samplers for high or low concentrations of VOCs. If a high concentration is present, one of the remaining samples in the En Core devices can be extruded into methanol for high-level analysis; if a low concentration is present, the two remaining samples in the En Core devices can be extruded into two appropriate vials for low-level analysis giving an additional low-level sample for analysis, if needed. For guidance on sample collection, sample handling, and sample preparation methods for volatile organic analysis, see Guide D 4547. For quality assurance considerations related to field sampling, see Guide D 4687.

6.3 As stated in 4.8, the En Core device cannot be used for sampling cemented material, consolidated material, or material having fragments coarse enough to interfere with proper coring techniques.

6.4 *Sample Collection*—The manufacturer's specific instructions for operating the En Core sampler and T-handle to collect a soil sample should be followed. The steps involved in sample collection using the En Core sampler are given below.

6.4.1 Before collecting a sample in the En Core sampler, the plunger rod (see Fig. 1) should be positioned so that the plunger can be moved freely from the top to the bottom of the coring body/storage chamber. For sample collection, the T-handle (see Fig. 2) should be attached to the sampler, and the plunger should be positioned so that the bottom of the plunger

⁷ U.S. EPA, 1996, Method 5035: Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846)*, Vol. 1B, Final Update III.

⁸ U.S. EPA, 1996, Method 5021: Volatile Organic Compounds in Soils and Other Solid Matrices Using Equilibrium Headspace Analysis. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846)*, Vol. 1B, Final Update III.

is flush with the bottom of the coring body/storage chamber. This prevents air from being trapped in the device during sample collection. When inserting a coring device into a surface for sample collection, air should not be trapped behind the sample. If this occurs, air can pass through the soil causing VOCs to be lost, or it can cause the sample to be prematurely pushed from the coring device.

6.4.2 Sample collection should be performed as quickly as possible. Using the T-handle, push the En Core sampler into the soil until the coring body/storage chamber is completely full. It can be verified that the coring body/storage chamber is full by looking into the appropriate viewing hole (either 5 or 25-g) in the T-handle (see Fig. 2). The coring body/storage chamber is completely full if the small O-ring on the plunger rod (see Fig. 1) is centered in the T-handle viewing hole. If possible, look at the viewing hole while the device is in the soil to check if the coring body/storage chamber is completely full. If it is not possible to view the hole when the device is in the soil, remove the sampler from the soil to view the hole. If the coring body/storage chamber is not completely full, quickly insert the device back into the same sampling spot and push harder to fill the coring body/storage chamber. When the coring body/storage chamber is completely full, scrape a spatula across the bottom of the coring body/storage chamber so the surface of the soil in the sampler is flush with the opening of the coring body/storage chamber (see Note 2). Quickly wipe the external surface of the coring body/storage chamber with a clean tissue or cloth. After ensuring that the sealing surfaces are clean, cap the coring body/storage chamber while it is still on the T-handle. This is done by gently sliding the cap onto the coring body/storage chamber with a twisting motion. The cap is locked into position when the grooves on the locking arms seat over the ridge on the coring body/storage chamber (see Fig. 1). If the cap of the En Core sampler is difficult to lock into position, the O-ring in the cap (see Fig. 1) may be bent out of position, and a new cap should be used to seal the device. A bent O-ring in the cap may result in loss of VOCs from the stored sample (see 8.2.2). After the cap is locked into position, the T-handle is removed from the sampler, and the plunger is locked into position by rotating the plunger rod (see manufacturer's specific operating instructions).

NOTE 2—For drier soils that are difficult to compact in the sampler, scraping a spatula across the surface of the soil to make it flush with the opening of the coring body/storage chamber may loosen particles of the soil in the coring body/storage chamber. These particles may scatter when the device is capped and may affect the seal between the cap and coring body/storage chamber (see 8.2.2). Caution should be used when working with these types of soils to prevent this from happening.

6.4.3 A sample label showing the sample number is attached to the cap of the En Core sampler, and the sampler is placed in its protective moisture-proof shipping bag (provided with each En Core sampler). This bag has a label attached for recording sample name, date collected, comments, and sample number.

6.5 *Sample Storage*—The capped coring body immediately becomes a sealed sample storage chamber. A sample can be stored in the sealed coring body/storage chamber at $4 \pm 2^\circ\text{C}$ for up to 48 h; at -7 to -21°C for up to 14 days; or at $4 \pm 2^\circ\text{C}$

for up to 48 h followed by storage at -7 to -21°C for up to five days (see Appendix X1 and reports referenced in footnotes 4, 5, and 6 for information on the performance of the En Core sampler under these storage conditions).^{4,5,6} Storage of samples in the En Core sampler at $4 \pm 2^\circ\text{C}$ or -7 to -21°C for longer holding times than those listed above is an option, provided it can be shown that the longer storage time used does not influence the concentrations of the VOCs of interest in the samples, or that the data generated by analysis of the samples meet the DQOs (see Practice D 5792). Data showing performance of the En Core sampler as a storage chamber for samples of soil stored under a variety of conditions, including $4 \pm 2^\circ\text{C}$ for 48 h; $-7 \pm 1^\circ\text{C}$ for 14 days; $-12 \pm 2^\circ\text{C}$ for 14 days; $-21 \pm 2^\circ\text{C}$ for 14 days; $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-7 \pm 1^\circ\text{C}$ for five days; $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-12 \pm 2^\circ\text{C}$ for five days; and $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-21 \pm 2^\circ\text{C}$ for five days, are given in Appendix X1.

6.5.1 Storage of samples at $4 \pm 2^\circ\text{C}$ can be achieved by placing the protective shipping bag, in which the En Core sampler has been placed, in a cooler with ice or cold packs, or in a refrigerated compartment regulated at $4 \pm 2^\circ\text{C}$. For storage at -7 to -21°C , the En Core sampler should be stored in a freezer compartment regulated at a temperature within the range of -7 to -21°C . A minimum/maximum temperature monitor, such as a minimum/maximum thermometer or temperature data logger should be placed with the samples during storage to verify that the temperature requirement is maintained.

6.6 Arrangements with the receiving laboratory for sample log in, sample handling, required storage conditions, and analysis should be made.

6.7 *Extrusion of the Soil Sample from the En Core Sampler*—The manufacturer's specific instructions for operating the En Core sampler and extrusion tool to extrude the soil sample from the coring body/storage chamber should be followed. The steps involved in sample extrusion from the En Core sampler are outlined in 6.7.1.

6.7.1 At the laboratory, the soil is transferred into the appropriate container without disturbing the integrity of the sample by removing the cap from the coring body/storage chamber and using the plunger to expel the soil into the receiving container (see Note 3). This is done by performing the following steps in accordance with the manufacturer's specific operating instructions: attach the extrusion tool (see Fig. 2) to the En Core sampler; rotate the extrusion tool plunger knob into position for sample extrusion; unlock the locking arms of the cap; carefully remove the cap from the sampler; and, push down on the plunger knob of the extrusion tool (see Fig. 2) to expel the sample from the coring body/storage chamber directly into the appropriate container for analysis or preservation (see Guide D 4547). After the sample is expelled from the En Core sampler, the O-ring in the sampler cap should be inspected to make sure that the O-ring was not bent when the cap was placed on the coring body/storage chamber. A bent

O-ring in the sampler cap can result in loss of VOCs from the stored sample and should be documented (see 8.2.2).

Note 3—Samples that have been stored at -7 to -21°C should be allowed to sit at room temperature for 2 to 3 min before extrusion from the En Core sampler, which will facilitate extrusion of the frozen sample from the device.

7. Report

7.1 For guidance on information that should be recorded for a sampling activity, see Guide D 4687.

8. Precision and Bias

8.1 *Precision*—The estimated percent relative standard deviations of low-level ($<200\text{ }\mu\text{g/Kg}$) concentrations of methyl-ene chloride (MeCl_2), methyl tert-butyl ether (MTBE), 1,1-dichloroethane, *cis*-1,2-dichloroethylene (CDCE), chloroform, benzene, trichloroethylene (TCE), toluene, tetrachloroethylene (PCE), ethyl benzene, and *o*-xylene due to storage of spiked samples of two different soils in the 5-g and 25-g En Core samplers have been shown to range from 0 to 10 % for the following conditions: $4 \pm 2^{\circ}\text{C}$ for 48 h; $4 \pm 2^{\circ}\text{C}$ for seven days; $-12 \pm 2^{\circ}\text{C}$ for seven days; $-12 \pm 2^{\circ}\text{C}$ for 14 days; $4 \pm 2^{\circ}\text{C}$ for 48 h followed by $-12 \pm 2^{\circ}\text{C}$ for five days; and $4 \pm 2^{\circ}\text{C}$ for 48 h followed by $-12 \pm 2^{\circ}\text{C}$ for twelve days. For storage of samples at $4 \pm 2^{\circ}\text{C}$ for 14 days, these values range from 0 to 14 % for the compounds listed above. For vinyl chloride, the values range from 0 to 14 % for all of the storage conditions.⁵

8.2 *Bias*—No information can be given on the bias of the sampling/storage procedure described in this practice because there is no standard reference material for sampling soil for VOCs in the field.

8.2.1 Data have been generated to provide information on the performance of the En Core sampler for storage of soil samples spiked with VOCs at low-level concentrations of

approximately $100\text{ }\mu\text{g/Kg}$. Performance of the device for storage of the spiked soil at $4 \pm 2^{\circ}\text{C}$ for 48 h, at $4 \pm 2^{\circ}\text{C}$ for seven days, at $4 \pm 2^{\circ}\text{C}$ for 14 days, at $-7 \pm 1^{\circ}\text{C}$ for 14 days, at $4 \pm 2^{\circ}\text{C}$ for 48 h followed by storage at $-7 \pm 1^{\circ}\text{C}$ for five days, at $-12 \pm 2^{\circ}\text{C}$ for seven days, at $-12 \pm 2^{\circ}\text{C}$ for 14 days, at $4 \pm 2^{\circ}\text{C}$ for 48 h followed by storage at $-12 \pm 2^{\circ}\text{C}$ for five days, at $4 \pm 2^{\circ}\text{C}$ for 48 h followed by storage at $-12 \pm 2^{\circ}\text{C}$ for 12 days, at $-21 \pm 2^{\circ}\text{C}$ for 14 days, and at $4 \pm 2^{\circ}\text{C}$ for 48 h followed by storage at $-21 \pm 2^{\circ}\text{C}$ for five days has been evaluated. Data from these evaluations are shown in Appendix X1.^{6,9}

8.2.2 A study involving storage of soil samples spiked with VOCs at high-level concentrations of approximately $2,500\text{ }\mu\text{g/Kg}$ has also been conducted. The data and findings from this study are discussed in research report RR: D34-1012¹⁰.

8.2.3 Data showing the performance of the 25-g disposable En Core sampler to store soil samples spiked with EPA Method 1311¹¹ volatile organic analytes are shown in Appendix X2.⁹ Storage conditions used were 14 days at $4 \pm 2^{\circ}\text{C}$, 14 days at $-12 \pm 2^{\circ}\text{C}$, and 48 h at $4 \pm 2^{\circ}\text{C}$ followed by 12 days at $-12 \pm 2^{\circ}\text{C}$.

9. Keywords

9.1 En Core sampler; soil sampling; storage of soil samples; volatile organic compounds (VOCs); VOC analysis

⁵ Copies of the research reports on the studies described in Appendix X1 are available from ASTM Headquarters. Request RR: D34-1013 and RR: D34-1015. RR: D34-1013 also gives information on the study described in Appendix X2.

¹⁰ A copy of the research report on the study described in 8.2.2 is available from ASTM Headquarters. Request RR:D34-1012.

¹¹ U.S. EPA, 1992, Method 1311, Toxicity Characteristic Leaching Procedure, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846), Vol 1C.

APPENDIXES

(Nonmandatory Information)

X1. PERFORMANCE OF THE EN CORE SAMPLER TO STORE LOW-LEVEL VOC-SPIKED SOIL SAMPLES

X1.1 A study was conducted to evaluate the performance of the 5- and 25-g En Core samplers to store three different soil types spiked with an aqueous solution containing eleven volatile organic compounds (VOCs). The En Core samplers used in this study were manufactured at the end of 1999 and in 2000. The 5-g devices that were used represent lot numbers K119333, K110073, K110167, and K110259. The 25-g devices that were used represent lot numbers K119349, K110053, and K110154. The manufacturer can be contacted for information on these lot numbers.

X1.1.1 The soils used in the study are representative of different environments and contained native microbial populations. They are a river bank soil having 49 % sand, 26 % silt, 24 % clay, 5.3 % organic material, approximately 14 % moisture, and a dehydrogenase (microbial) activity of 22 mg total product formed (TPF)/g/24 h; a mountain soil having 75 %

sand, 13 % silt, 12 % clay, 4.3 % organic material, approximately 12 % moisture, and a dehydrogenase activity of 11 mg TPF/g/24 h; and, a prairie soil having 67 % sand, 17 % silt, 16 % clay, 1.5 % organic material, approximately 8 % moisture, and a dehydrogenase activity of 17 mg TPF/g/24 h.

X1.1.2 The VOCs used in the study are methylene chloride (MeCl_2), methyl tert-butyl ether (MTBE), 1,1-dichloroethane, *cis*-1,2-dichloroethylene (CDCE), chloroform, benzene, trichloroethylene (TCE), toluene, tetrachloroethylene, (PCE), ethyl benzene, and *o*-xylene. These compounds were selected as the analytes of interest because they are representative of halogenated and aromatic compounds that are of environmental concern.

X1.1.3 In the study, soil samples were collected in the En Core samplers from a large container of loose soil and then spiked with an aqueous solution containing the compounds

TABLE X1.1 Storage Conditions for Low-Level Testing of the Disposable En Core Samplers

Storage Times and Conditions	Number of Samples
No Storage (Time-zero)	5 samples
48 h in a cooler at $4 \pm 2^\circ\text{C}$	5 samples
48 h in a cooler at $4 \pm 2^\circ\text{C}$, then 5 days at $4 \pm 2^\circ\text{C}$ in a refrigerator	5 samples
48 h in a cooler at $4 \pm 2^\circ\text{C}$, then 5 days at $-12 \pm 2^\circ\text{C}$ in a freezer	5 samples
7 days at $-12 \pm 2^\circ\text{C}$ in a freezer	5 samples
48 h in a cooler at $4 \pm 2^\circ\text{C}$, then 12 days at $4 \pm 2^\circ\text{C}$ in a refrigerator	5 samples
48 h in a cooler at $4 \pm 2^\circ\text{C}$, then 12 days at $-12 \pm 2^\circ\text{C}$ in a freezer	5 samples
14 days at $-12 \pm 2^\circ\text{C}$ in a freezer	5 samples

listed in X1.1.2. The spiking solution was prepared by adding 250 μL of gasoline to approximately 80 mL of VOC-free water in a 100-mL volumetric flask and diluting to volume. The mixture was stirred for 24 h, and then the gasoline was separated from the water using a separatory funnel. The resulting gasoline-saturated water was added to a 40-mL VOA vial, and a methanol solution containing the compounds of interest, except for benzene and toluene, was injected into the gasoline-saturated water. The benzene and toluene present in the spiking solution came totally from the gasoline-saturated water. The 5-g samples were spiked with 100 μL of spiking solution, and the 25-g samples were spiked with 0.5 mL of the spiking solution to give an approximate concentration of 100 $\mu\text{g/Kg}$ of each analyte of interest in the samples, with the exception of benzene, toluene, and o-xylene. Because of their presence in the gasoline-saturated water, the concentrations of benzene ranged from approximately 70 to 300 $\mu\text{g/Kg}$ and the concentrations of toluene ranged from approximately 300 to 900 $\mu\text{g/Kg}$ in the spiked soil samples. Additional o-xylene and ethyl benzene were also added to the spiking solution by the gasoline-saturated water. This resulted in o-xylene and ethyl benzene concentrations in the spiked soil samples at approximately 200 $\mu\text{g/Kg}$ and approximately 100 $\mu\text{g/Kg}$, respectively.

X1.1.4 After all samples were spiked and capped, five random samples for each soil type were extruded from each size of En Core sampler into methanol for analysis to give time-zero concentrations of the analytes of interest. The remaining samples were stored under the storage conditions shown in Table X1.1. Storage temperatures were monitored to make sure they were at the specified temperature. The temperatures in the coolers and refrigerator used to store the samples at 4°C and in the freezer used to store the samples at -12°C were monitored using minimum/maximum thermometers. After the samples were held for the appropriate times, they were extruded into methanol for extraction and analysis.

The methanol extracts of the samples were analyzed using EPA Method 8260B¹² and 5030B.¹³

X1.1.5 To evaluate the data, the mean concentrations of the analytes of interest in the stored samples were compared to their mean concentrations in the time-zero samples by calculating average percent recovery. Before average percent recovery was calculated, the data sets were evaluated for outlier data points as described in Practice D 2777 and Grubbs.¹⁴

X1.1.6 The data generated by this testing are specific to the experimental design of the study. The data give information on the performance of the En Core samplers for storing soil samples collected from loose soil, spiked with a gasoline-saturated water solution containing selected analytes of interest, and then stored under specific storage conditions. The data generated by this testing also are specific to the soils used in the study, the analytes of interest, the analyte concentrations, and the storage conditions that were evaluated. For other soil types, analytes, analyte concentrations, and storage conditions, these data may not apply.

X1.1.7 The average percent recoveries of the VOCs of interest from samples of the river bank soil stored in the 5-g En Core samplers are shown in Table X1.2; and the average percent recoveries of the VOCs of interest from samples of the river bank soil stored in the 25-g En Core samplers are shown in Table X1.3. In each of these tables, the percent relative standard deviation of the concentration values in the stored samples is given in parentheses next to the corresponding average percent recovery value. The percent relative standard deviation of the concentration values in the time-zero samples is given in a footnote to each of the tables.

X1.1.7.1 As shown in Table X1.2 for the 5-g sampler, all of the VOCs of interest in this study have average percent recovery values of 90 % or greater for storage of the spiked river bank soil samples at $4 \pm 2^\circ\text{C}$ for 48 h, for storage at $-12 \pm 2^\circ\text{C}$ for seven days, for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-12 \pm 2^\circ\text{C}$ for five days, and for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-12 \pm 2^\circ\text{C}$ for 12 days. The mean of the 44 average percent recovery values listed in Table X1.2 for the analytes of interest for these four storage conditions is 99 % recovery with a standard deviation of 5 % and a percent relative standard deviation of 5 %. For storage at $4 \pm 2^\circ\text{C}$ for seven days and at $-12 \pm 2^\circ\text{C}$ for 14 days, average percent recovery values for all of the VOCs of interest are greater than 90 %, except for MeCl_2 , which has an average percent recovery of 60 % for both storage conditions, and MTBE, which has an average percent recovery of 84 % for storage at $-12 \pm 2^\circ\text{C}$ for 14 days. For storage at $4 \pm 2^\circ\text{C}$ for 14 days, average percent recovery values for the compounds of interest range from 74 % to 85 %, except for MeCl_2 , which has an average percent recovery value of 48 %.

¹² U.S. EPA, 1996, Method 8260B: Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846)*, Vol. 1B, Final Update III.

¹³ U.S. EPA, 1996, Method 5030B: Purge-and-Trap for Aqueous Samples, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846)*, Vol. 1B, Final Update III.

¹⁴ Grubbs, F. E., "Sample Criteria for Testing Outlying Observations," *Annals of Mathematical Statistics*, Vol. 21, March 1950, pp. 27-58.

TABLE X1.2 Average Percent Recoveries of Low-Level^a VOCs from Samples of River Bank Soil^b Stored in 5-g En Core Samplers

Storage Conditions:	4 ± 2°C/ 48 h	4 ± 2°C/ 7 Days	4 ± 2°C/ 14 Days	-12 ± 2°C/ 7 Days	-12 ± 2°C/ 14 Days	4 ± 2°C 48 h/ -12 ± 2°C 5 Days	4 ± 2°C 48 h/ -12 ± 2°C 12 Days
VOCs							
MeCl ₂	103 ^c (15) ^d	60 (16)	48 (44)	99 (4)	60 (32)	103 (4)	92 (22)
MTBE	105 (3)	109 (8)	81 (18)	104 (3)	84 (9)	93 (5)	90 (12)
1,1-Dichloroethane	107 (3)	99 (6)	78 (24)	102 (3)	96 (10)	92 (5)	98 (5)
CDCE	104 (3)	97 (3)	80 (14)	101 (7)	95 (8)	91 (7)	94 (12)
Chloroform	99 (7)	104 (6)	83 (15)	96 (6)	93 (6)	94 (7)	94 (12)
Benzene	104 (5)	92 (4)	77 (13)	104 (7)	97 (6)	90 (4)	94 (12)
TCE	105 (6)	98 (3)	85 (8)	102 (8)	98 (3)	97 (7)	99 (4)
Toluene	92 (7)	95 (5)	74 (8)	108 (7)	102 (2)	93 (8)	97 (10)
PCE	97 (10)	100 (4)	85 (6)	99 (5)	96 (5)	100 (10)	96 (7)
Ethyl benzene	96 (8)	95 (7)	85 (6)	105 (7)	94 (4)	99 (8)	101 (10)
o-Xylene	99 (7)	94 (6)	79 (6)	103 (7)	97 (3)	98 (7)	100 (8)

^a Concentrations of the VOCs in the samples were ~100 µg/Kg, except for benzene concentrations ranging from ~70 to ~300 µg/Kg, toluene concentrations ranging from ~300 to ~900 µg/Kg, and o-xylene concentrations at ~200 µg/Kg.

^b The river bank soil is 49 % sand, 26 % silt, 24 % clay, 5.3 % organic material, and ~14 % moisture.

^c Average percent recovery is based on mean concentration values determined for five time-zero samples and five stored samples minus outlier data points.

^d The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 2 to 11 %, except for methylene chloride for which values ranged from 5 to 19 %.

TABLE X1.3 Average Percent Recoveries of Low-Level^a VOCs from Samples of River Bank Soil^b Stored in 25-g En Core Samplers

Storage Conditions:	4 ± 2°C/ 48 h	4 ± 2°C/ 7 Days	4 ± 2°C/ 14 Days	-12 ± 2°C/ 7 Days	-12 ± 2°C/ 14 Days	4 ± 2°C 48 h/ -12 ± 2°C 5 Days	4 ± 2°C 48 h/ -12 ± 2°C 12 Days
VOCs							
MeCl ₂	96 ^c (5) ^d	94 (8)	88 (8)	94 (2)	93 (5)	105 (6)	72 (17)
MTBE	97 (6)	108 (6)	102 (5)	104 (10)	83 (2)	108 (4)	74 (12)
1,1-Dichloroethane	98 (3)	102 (6)	95 (3)	103 (3)	104 (2)	102 (3)	83 (10)
CDCE	98 (2)	97 (5)	84 (5)	101 (4)	100 (3)	100 (3)	80 (12)
Chloroform	98 (1)	102 (6)	96 (6)	102 (1)	102 (3)	102 (3)	77 (10)
Benzene	97 (2)	97 (7)	88 (4)	95 (3)	107 (5)	98 (1)	86 (11)
TCE	100 (3)	106 (9)	97 (1)	98 (3)	103 (4)	102 (3)	90 (11)
Toluene	98 (4)	102 (5)	92 (5)	99 (5)	103 (4)	105 (1)	81 (11)
PCE	100 (3)	105 (4)	97 (6)	101 (5)	110 (6)	100 (4)	90 (4)
Ethyl benzene	98 (4)	96 (7)	88 (1)	101 (1)	99 (4)	96 (4)	93 (10)
o-Xylene	99 (2)	96 (7)	92 (3)	101 (1)	99 (4)	98 (3)	88 (11)

^a Concentrations of the VOCs in the samples were ~100 µg/Kg, except for benzene concentrations ranging from ~70 to ~300 µg/Kg, toluene concentrations ranging from ~300 to ~900 µg/Kg, and o-xylene concentrations at ~200 µg/Kg.

^b The river bank soil is 49 % sand, 26 % silt, 24 % clay, 5.3 % organic material, and ~14 % moisture.

^c Average percent recovery is based on mean concentration values determined for five time-zero samples and five stored samples minus outlier data points.

^d The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 1 to 15 % for all of the tests using the river bank soil in the 25-g devices.

X1.1.7.2 As shown in Table X1.3, for the 25-g sampler, all of the VOCs of interest have average percent recovery values greater than 90 % for storage of the spiked river bank soil samples at 4 ± 2°C for 48 h, for storage at 4 ± 2°C for seven days, for storage at -12 ± 2°C for seven days, and for storage at 4 ± 2°C for 48 h followed by storage at -12 ± 2°C for five days. The mean of the 44 average percent recovery values listed in Table X1.3 for the analytes of interest for these four storage conditions is 100 % recovery with a standard deviation of 4 % and a percent relative standard deviation of 4 %. For storage at -12 ± 2°C for 14 days, the average percent recovery values for all of the analytes are greater than 90 %, except for MTBE, which has an average percent recovery value of 83 %. For storage at 4 ± 2°C for 14 days, the average percent recovery values for all of the analytes are greater than 80 %. As shown in Table X1.3, for storage at 4 ± 2°C for 48 h followed by storage at -12 ± 2°C for 12 days, the average percent recovery values for the analytes of interest are also greater than

80 %, except for MeCl₂ at 72 % recovery, MTBE at 74 % recovery, and chloroform at 77 % recovery.

X1.1.8 The average percent recoveries of the VOCs of interest from samples of the mountain soil stored in the 5-g En Core samplers are shown in Table X1.4; and the average percent recoveries of the VOCs of interest from samples of the mountain soil stored in the 25-g En Core samplers are shown in Table X1.5. In each of these tables, the percent relative standard deviation of the concentration values in the stored samples is given in parentheses next to the corresponding average percent recovery value. The percent relative standard deviation of the concentration values in the time-zero samples is given in a footnote to each of the tables.

X1.1.8.1 As shown in Table X1.4 for the En Core sampler, all of the VOCs of interest in this study have average percent recovery values greater than 90 % for storage of the spiked mountain soil samples at -12 ± 2°C for seven days and for storage at 4 ± 2°C for 48 h followed by storage at -12 ± 2°C

TABLE X1.4 Average Percent Recoveries of Low-Level^A VOCs from Samples of Mountain Soil^B Stored in 5-g En Core Samplers

Storage Conditions:	4 ± 2°C/ 48 h	4 ± 2°C/ 7 Days	4 ± 2°C/ 14 Days	-12 ± 2°C/ 7 Days	-12 ± 2°C/ 14 Days	4 ± 2°C 48 h/ -12 ± 2°C 5 Days	4 ± 2°C 48 h/ -12 ± 2°C 12 Days
VOCs							
MeCl ₂	108 ^C (4) ^D	86 (2)	71 (13)	110 (6)	82 (13)	108 (10)	74 (10)
MTBE	105 (6)	98 (9)	100 (1)	103 (1)	100 (2)	101 (1)	100 (2)
1,1-Dichloroethane	90 (8)	86 (11)	88 (2)	99 (7)	100 (8)	99 (6)	96 (6)
CDCE	87 (6)	75 (3)	77 (3)	97 (5)	99 (8)	92 (6)	91 (7)
Chloroform	87 (5)	85 (2)	76 (0.3)	107 (1)	103 (7)	102 (3)	105 (6)
Benzene	92 (6)	81 (10)	76 (7)	94 (6)	94 (7)	93 (4)	92 (2)
TCE	97 (6)	90 (10)	88 (6)	98 (7)	100 (7)	103 (4)	103 (5)
Toluene	91 (6)	74 (4)	76 (6)	96 (4)	100 (4)	92 (3)	97 (3)
PCE	98 (7)	92 (9)	88 (8)	94 (2)	99 (6)	102 (4)	104 (4)
Ethyl benzene	97 (6)	83 (3)	82 (4)	100 (3)	98 (5)	98 (3)	98 (3)
o-Xylene	98 (4)	92 (11)	84 (3)	102 (3)	102 (6)	103 (3)	99 (3)

^A Concentrations of the VOCs in the samples were ~100 µg/Kg, except for benzene concentrations ranging from ~70 to ~300 µg/Kg, toluene concentrations ranging from ~300 to ~900 µg/Kg, and o-xylene concentrations at ~200 µg/Kg.

^B The mountain soil is 75 % sand, 13 % silt, 12 % clay, 4.3 % organic material, and ~12 % moisture.

^C Average percent recovery is based on mean concentration values determined for five time-zero samples and five stored samples minus outlier data points. Testing was performed 5/2000 through 6/2000.

^D The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 1 to 9 %, except for methylene chloride, for which the percent relative standard deviation value was 21 % for storage conditions of 4 ± 2°C/48 h, 4 ± 2°C/7 days, 4 ± 2°C 48 h/-12 ± 2°C 5 days, and -12 ± 2°C/7 days; and 8 % for the other storage conditions.

TABLE X1.5 Average Percent Recoveries of Low-Level^A VOCs from Samples of Mountain Soil^B Stored in 25-g En Core Samplers

Storage Conditions:	4 ± 2°C/ 48 h	4 ± 2°C/ 7 Days	4 ± 2°C/ 14 Days	-12 ± 2°C/ 7 Days	-12 ± 2°C/ 14 Days	4 ± 2°C 48 h/ -12 ± 2°C 5 Days	4 ± 2°C 48 h/ -12 ± 2°C 12 Days
VOCs							
MeCl ₂	97 ^C (5) ^D	88 (5)	91 (4)	102 (4)	98 (5)	104 (5)	97 (7)
MTBE	103 (3)	101 (0)	103 (4)	101 (2)	100 (3)	102 (3)	100 (4)
1,1-Dichloroethane	98 (2)	94 (2)	98 (3)	100 (1)	100 (3)	99 (2)	99 (4)
CDCE	97 (1)	89 (3)	91 (5)	99 (1)	100 (2)	98 (1)	98 (7)
Chloroform	98 (4)	91 (1)	102 (2)	99 (2)	104 (3)	96 (1)	101 (3)
Benzene	99 (2)	91 (3)	90 (2)	102 (2)	103 (3)	98 (1)	101 (4)
TCE	100 (2)	100 (1)	97 (3)	101 (2)	99 (3)	100 (2)	102 (3)
Toluene	100 (4)	93 (2)	87 (4)	100 (3)	99 (4)	98 (3)	98 (4)
PCE	101 (1)	100 (1)	100 (3)	98 (2)	101 (4)	99 (2)	102 (4)
Ethyl benzene	103 (1)	98 (1)	92 (2)	99 (4)	98 (5)	101 (5)	100 (3)
o-Xylene	101 (2)	103 (1)	98 (3)	100 (1)	102 (3)	102 (3)	97 (3)

^A Concentrations of the VOCs in the samples were ~100 µg/Kg, except for benzene concentrations ranging from ~70 to ~300 µg/Kg, toluene concentrations ranging from ~300 to ~900 µg/Kg, and o-xylene concentrations at ~200 µg/Kg.

^B The mountain soil is 75 % sand, 13 % silt, 12 % clay, 4.3 % organic material, and ~12 % moisture.

^C Average percent recovery is based on mean concentration values determined for five time-zero samples and five stored samples minus outlier data points. Testing was performed 6/2000 through 7/2000.

^D The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 1 to 7 % for the tests using the mountain soil in the 25-g devices.

for five days. In addition, for storage at 4 ± 2°C for 48 h, all of the analytes of interest have average percent recovery values of 90 % or greater, except for CDCE and chloroform, which have average percent recovery values of 87 %. The mean of the 33 average percent recovery values listed in Table X1.4 for the analytes of interest for the three storage conditions discussed above is 98 % recovery with a standard deviation of 6 % and a percent relative standard deviation of 6 %. For storage at -12 ± 2°C for 14 days and at 4 ± 2°C for 48 h followed by storage at -12 ± 2°C for 12 days, average percent recovery values are also greater than 90 %, except for MeCl₂, which has an average percent recovery of 82 % for storage at -12 ± 2°C for 14 days and 74 % for storage at 4 ± 2°C for 48 h followed by storage at -12 ± 2°C for 12 days. For storage at 4 ± 2°C for seven days, the analytes of interest have average percent recovery values greater than 80 %, except for CDCE at 75 % and

toluene at 74 %. Lastly, for storage at 4 ± 2°C for 14 days, average percent recovery values are 100 % for MTBE; 88 % for 1,1-dichloroethane, TCE, and PCE; 76 % to 84 % for chloroform, benzene, toluene, CDCE, ethyl benzene, and o-xylene; and 71 % for MeCl₂.

X1.1.8.2 As shown in Table X1.5 for the 25-g En Core sampler, all of the VOCs of interest have average percent recovery values greater than 90 % for storage of the spiked mountain soil samples under all of the storage conditions used in this study. The only exceptions are MeCl₂ at 88 % recovery and CDCE at 89 % recovery for storage at 4 ± 2°C for seven days, and benzene at 90 % recovery and toluene at 87 % recovery for storage at 4 ± 2°C for 14 days. The mean of the 77 average percent recovery values listed in Table X1.5 for the

TABLE X1.6 Average Percent Recoveries of Low-Level^A VOCs from Samples of Prairie Soil^B Stored in 5-g En Core Samplers

Storage Conditions:	4 ± 2°C/ 48 h	4 ± 2°C/ 7 Days	4 ± 2°C/ 14 Days	-12 ± 2°C/ 7 Days	-12 ± 2°C/ 14 Days	4 ± 2°C 48 h/ -12 ± 2°C 5 Days	4 ± 2°C 48 h/ -12 ± 2°C 12 Days
VOCs							
Vinyl Chloride	87 ^C (2) ^D	93 (9)	76 (10)	103 (10)	91 (9)	103 (3)	87 (16)
MeCl ₂	87 (3)	88 (8)	76 (13)	95 (3)	95 (8)	102 (1)	89 (9)
MTBE	94 (2)	101 (7)	99 (4)	102 (5)	103 (4)	101 (5)	103 (6)
1,1-Dichloroethane	91 (4)	85 (9)	73 (9)	100 (4)	95 (8)	97 (2)	89 (8)
CDCE	97 (2)	75 (9)	62 (15)	94 (9)	88 (6)	89 (1)	81 (11)
Chloroform	90 (1)	87 (7)	77 (8)	95 (1)	94 (6)	96 (3)	92 (9)
Benzene	89 (4)	71 (10)	53 (10)	98 (5)	95 (5)	91 (2)	85 (9)
TCE	90 (5)	73 (7)	63 (12)	97 (6)	97 (6)	93 (3)	91 (9)
Toluene	80 (5)	57 (15)	32 (13)	93 (2)	90 (8)	85 (2)	74 (13)
PCE	90 (5)	72 (10)	56 (13)	96 (5)	100 (5)	91 (5)	93 (10)
Ethyl benzene	87 (5)	65 (15)	36 (12)	98 (11)	99 (4)	89 (3)	86 (8)
o-Xylene	85 (6)	58 (15)	37 (12)	96 (4)	98 (4)	84 (6)	84 (8)

^A Concentrations of the VOCs in the samples were ~100 µg/Kg, except for benzene concentrations ranging from ~70 to ~300 µg/Kg, toluene concentrations ranging from ~300 to ~900 µg/Kg, and o-xylene concentrations at ~200 µg/Kg.

^B The prairie soil is 67 % sand, 17 % silt, 16 % clay, 1.5 % organic material, and ~8 % moisture.

^C Average percent recovery is based on mean concentration values determined for five time-zero samples and five stored samples minus outlier data points.

^D The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 1 to 14 % for all of the tests using the prairie soil in the 5-g devices.

TABLE X1.7 Average Percent Recoveries of Low-Level^A VOCs from Samples of Prairie Soil^B Stored in 25-g En Core Samplers

Storage Conditions:	4 ± 2°C/ 48 h	4 ± 2°C/ 7 Days	4 ± 2°C/ 14 Days	-12 ± 2°C/ 7 Days	-12 ± 2°C/ 14 Days	4 ± 2°C 48 h/ -12 ± 2°C 5 Days	4 ± 2°C 48 h/ -12 ± 2°C 12 Days
VOCs							
Vinyl Chloride	95 ^C (8) ^D	92 (9)	87 (3)	105 (3)	88 (22)	93 (32)	92 (9)
MeCl ₂	93 (8)	73 (11)	72 (8)	82 (12)	86 (7)	82 (10)	89 (5)
MTBE	97 (8)	99 (9)	94 (4)	102 (2)	100 (6)	102 (3)	99 (2)
1,1-Dichloroethane	94 (5)	89 (6)	83 (4)	99 (6)	98 (6)	99 (8)	95 (3)
CDCE	94 (5)	82 (2)	75 (7)	95 (7)	95 (5)	95 (9)	91 (3)
Chloroform	97 (4)	89 (3)	89 (3)	96 (6)	102 (3)	98 (7)	100 (4)
Benzene	91 (5)	83 (4)	71 (5)	101 (5)	97 (4)	101 (7)	92 (3)
TCE	95 (3)	80 (4)	75 (6)	100 (1)	97 (6)	97 (7)	94 (2)
Toluene	88 (1)	67 (4)	54 (12)	100 (4)	98 (4)	97 (6)	92 (13)
PCE	96 (3)	84 (4)	71 (6)	101 (5)	99 (3)	102 (6)	97 (3)
Ethyl benzene	95 (3)	71 (5)	60 (10)	97 (3)	97 (5)	95 (4)	93 (0)
o-Xylene	95 (2)	64 (1)	57 (10)	98 (1)	100 (4)	94 (5)	93 (4)

^A Concentrations of the VOCs in the samples were ~100 µg/Kg, except for benzene concentrations ranging from ~70 to ~300 µg/Kg, toluene concentrations ranging from ~300 to ~900 µg/Kg, and o-xylene concentrations at ~200 µg/Kg.

^B The prairie soil is 67 % sand, 17 % silt, 16 % clay, 1.5 % organic material, and ~8 % moisture.

^C Average percent recovery is based on mean concentration values determined for five time-zero samples and five stored samples minus outlier data points.

^D The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 2 to 10 % for all of the tests using the prairie soil in the 25-g devices.

seven storage conditions is 99 % recovery with a standard deviation of 4 % and a percent relative standard deviation of 4 %.

X1.1.9 The average percent recoveries of the VOCs of interest from samples of the prairie soil stored in the 5-g En Core samplers are shown in Table X1.6; and the average percent recoveries of the VOCs of interest from samples of the prairie soil stored in the 25-g En Core samplers are shown in Table X1.7. In each of these tables, the percent relative standard deviation of the concentration values in the stored samples is given in parentheses next to the corresponding average percent recovery value. The percent relative standard deviation of the concentration values in the time-zero samples is given in a footnote to each of the tables.

X1.1.9.1 As shown in Table X1.6 and Table X1.7, vinyl chloride was added to the list of analytes of interest for the testing involving the prairie soil. This was done because in

previous testing involving the prairie soil (see 8.2.2), the seals of some of the En Core samplers were affected by particles of this dry, loose soil, which scattered during capping of the devices. Because vinyl chloride is a very volatile compound, average percent recovery values for this analyte serve as a good indicator of loss from the samplers by volatilization due to compromised seals. In this study, to reduce the possibility of particles scattering, the surface of the prairie soil samples in the En Core devices were patted down prior to capping.

X1.1.9.2 As shown in Table X1.6 for the 5-g En Core sampler, all of the VOCs of interest have average percent recovery values equal to or greater than 90 % for storage of the spiked prairie soil samples at -12 ± 2°C for seven days, and for storage at -12 ± 2°C for 14 days, except for CDCE, which has an average percent recovery of 88 % for storage at -12 ± 2°C for 14 days. The mean of the 24 average percent recovery values listed in Table X1.6 for the analytes of interest for these



TABLE X1.8 Average Percent Recoveries of Low-Level^a VOCs from Samples of Mountain Soil^b Stored in 5-g En Core Samplers at $-7 \pm 1^\circ\text{C}$ and $-21 \pm 2^\circ\text{C}$

Storage Conditions:	$-7 \pm 1^\circ\text{C}$ 14 days	$48 \text{ h}/4 \pm 2^\circ\text{C}$ 5 days/ $-7 \pm 1^\circ\text{C}$	$-21 \pm 2^\circ\text{C}$ 14 days	$48 \text{ h}/4 \pm 2^\circ\text{C}$ 5 days/ $-21 \pm 2^\circ\text{C}$
VOCs				
MeCl ₂	88 ^c (3) ^D	96(7)	39(4)	95(9)
MTBE	93(3)	93(8)	101(2)	98(5)
1,1-Dichloroethane	98(3)	101(7)	39(4)	98(7)
CDCE	97(4)	95(7)	39(6)	97(12)
Chloroform	96(3)	104(5)	92(2)	98(8)
Benzene	92(7)	94(7)	85(2)	92(8)
TCE	95(6)	97(5)	88(3)	95(8)
Toluene	99(5)	100(5)	88(1)	97(6)
PCE	98(5)	102(4)	90(5)	97(6)
Ethyl benzene	96(5)	102(4)	91(2)	96(7)
o-Xylene	102(5)	104(5)	39(0.4)	96(6)

^a Concentrations of the VOCs in the samples were $\sim 100 \mu\text{g/Kg}$, except for benzene concentrations at $\sim 200 \mu\text{g/Kg}$ to $\sim 400 \mu\text{g/Kg}$, toluene concentrations at $\sim 650 \mu\text{g/Kg}$ to $\sim 900 \mu\text{g/Kg}$, ethyl benzene concentrations at $\sim 200 \mu\text{g/Kg}$, and o-xylene concentrations at $\sim 300 \mu\text{g/Kg}$.

^b The mountain soil is 75 % sand, 13 % silt, 12 % clay, 4.3 % organic material, and ~ 12 % moisture.

^c Average percent recovery is based on mean concentration values determined for 5 time-zero samples and 5 stored samples minus outlier data points.

^D The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 2 to 10 %.

TABLE X1.9 Average Percent Recoveries of Low-Level^a VOCs from Samples of Mountain Soil^b Stored in 25-g En Core Samplers at $-7 \pm 1^\circ\text{C}$ and $-21 \pm 2^\circ\text{C}$

Storage Conditions:	$-7 \pm 1^\circ\text{C}$ 14 days	$48 \text{ h}/4 \pm 2^\circ\text{C}$ 5 days/ $-7 \pm 1^\circ\text{C}$	$-21 \pm 2^\circ\text{C}$ 14 days	$48 \text{ h}/4 \pm 2^\circ\text{C}$ 5 days/ $-21 \pm 2^\circ\text{C}$
VOCs				
MeCl ₂	94 ^c (3) ^D	98(2)	98(5)	96(3)
MTBE	105(4)	104(3)	94(1)	100(7)
1,1-Dichloroethane	96(2)	99(3)	98(5)	95(3)
CDCE	96(2)	97(2)	99(5)	96(3)
Chloroform	100(3)	99(2)	99(5)	97(2)
Benzene	93(4)	96(1)	99(3)	99(5)
TCE	98(3)	99(4)	96(3)	98(4)
Toluene	98(2)	100(2)	101(0.5)	97(3)
PCE	97(4)	101(2)	103(4)	102(3)
Ethyl benzene	97(3)	93(2)	98(0.4)	100(3)
o-Xylene	94(3)	96(3)	100(0.5)	100(2)

^a Concentrations of the VOCs in the samples were $\sim 100 \mu\text{g/Kg}$, except for benzene concentrations at $\sim 200 \mu\text{g/Kg}$ to $\sim 400 \mu\text{g/Kg}$, toluene concentrations at $\sim 650 \mu\text{g/Kg}$ to $\sim 900 \mu\text{g/Kg}$, ethyl benzene concentrations at $\sim 200 \mu\text{g/Kg}$, and o-xylene concentrations at $\sim 300 \mu\text{g/Kg}$.

^b The mountain soil is 75 % sand, 13 % silt, 12 % clay, 4.3 % organic material, and ~ 12 % moisture.

^c Average percent recovery is based on mean concentration values determined for 5 time-zero samples and 5 stored samples minus outlier data points.

^D The value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 4 to 6 %.

two storage conditions is 96 % recovery with a standard deviation of 4 % and a percent relative standard deviation of 4 %. In addition, all of the VOCs of interest have average percent recovery values of 80 % or greater for storage of the spiked prairie soil samples at $4 \pm 2^\circ\text{C}$ for 48 h, for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-12 \pm 2^\circ\text{C}$ for five days, and for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-12 \pm 2^\circ\text{C}$ for 12 days, except for toluene, which has an average percent recovery of 74 % for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-12 \pm 2^\circ\text{C}$ for 12 days. The mean of the 36 average percent recovery values listed in Table X1.6 for the analytes of interest for these three storage conditions is

TABLE X1.10 Summary of Average Percent Recoveries of Low-Level VOCs from Soil Samples Stored in the Disposable En Core Samplers

Soil Type/ Sample Size	Average Percent Recovery	Storage Condition	Analytes of Interest
River Bank, 5-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h	All ^a
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
River Bank, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 7 days	All except MeCl ₂ at 60 %
		$-12 \pm 2^\circ\text{C}$ for 14 days	All except MeCl ₂ at 60 %
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
Mountain, 5-g	90 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All except MeCl ₂ at 72 %; MTBE at 74 %; chloroform at 77 %
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-7 \pm 1^\circ\text{C}$ for 5 days	All
Mountain, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All except MeCl ₂ at 74 %
Prairie, 5-g	80 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h	All ^a
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$-21 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	80 % or Greater	$4 \pm 2^\circ\text{C}$ for 7 days	All except CDCE at 75 % and toluene at 74 %
		$4 \pm 2^\circ\text{C}$ for 14 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	90 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All
Prairie, 5-g	80 % or Greater	$-12 \pm 2^\circ\text{C}$ for 14 days	All
		$4 \pm 2^\circ\text{C}$ for 7 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h	All
		$-12 \pm 2^\circ\text{C}$ for 14 days	All
Prairie, 25-g	90 % or Greater	$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 5 days	All
		$4 \pm 2^\circ\text{C}$ for 48 h/ $-12 \pm 2^\circ\text{C}$ for 12 days	All
		$-12 \pm 2^\circ\text{C}$ for 7 days	All
		$-7 \pm 1^\circ\text{C}$ for 14 days	All

TABLE X1.10 Continued

Soil Type/ Sample Size	Average Percent Recovery	Storage Condition	Analytes of Interest
Prairie, 25-g	80 % or Greater	4 ± 2°C for 48 h	All ^{a,b}
		-12 ± 2°C for 7 days	All
		-12 ± 2°C for 14 days	All
		4 ± 2°C for 48 h/-12 ± 2°C for 5 days	All
		4 ± 2°C for 48 h/-12 ± 2°C for 12 days	All

^a The analytes of interest are MeCl₂, MTBE, 1,1-dichloroethane, CDCE, chloroform, benzene, TCE, toluene, PCE, ethyl benzene, and o-xylene.

^b Vinyl chloride is an additional analyte of interest for testing using the prairie soil.

TABLE X1.11 Summary of Average Percent Recoveries of Low-Level VOCs^a from Mountain Soil^b Stored in the Disposable En Core Samplers

Sample Size	Average % Recovery	Storage Condition
5-g	90 % or Greater	4 ± 2°C for 48 h/-7 ± 1°C for 5 days
		4 ± 2°C for 48 h/-12 ± 2°C for 5 days
		4 ± 2°C for 48 h/-21 ± 2°C for 5 days
		-12 ± 2°C for 7 days
5-g	80 % or Greater	4 ± 2°C for 48 h
		-7 ± 1°C for 14 days
		-12 ± 2°C for 14 days
		-21 ± 2°C for 14 days
25-g	90 % or Greater	4 ± 2°C for 48 h
		4 ± 2°C for 48 h/-7 ± 1°C for 5 days
		4 ± 2°C for 48 h/-12 ± 2°C for 5 days
		4 ± 2°C for 48 h/-21 ± 2°C for 5 days
		4 ± 2°C for 48 h/-12 ± 2°C for 12 days
		-12 ± 2°C for 7 days
		-7 ± 1°C for 14 days
		-12 ± 2°C for 14 days
25-g	80 % or Greater	4 ± 2°C for 7 days
		4 ± 2°C for 14 days

^a VOCs are MeCl₂, MTBE, 1,1-dichloroethane, CDCE, chloroform, benzene, TCE, toluene, PCE, ethyl benzene, and o-xylene.

^b The mountain soil is 75 % sand, 13 % silt, 12 % clay, 4.3 % organic material, and ~12 % moisture.

90 % recovery with a standard deviation of 6 % and a percent relative standard deviation of 7 %. For storage of the spiked prairie soil in the 5-g En Core sampler at 4 ± 2°C for seven days, average percent recovery values for vinyl chloride and MTBE are 93 % and 101 %, respectively. In addition, for this storage condition, average percent recovery values range from 85 % to 88 % for 1,1-dichloroethane, chloroform, and MeCl₂; from 71 % to 75 % for benzene, PCE, TCE, and CDCE; and from 57 % to 65 % for toluene, o-xylene, and ethyl benzene. For storage of the prairie soil samples at 4 ± 2°C for 14 days, the average percent recovery value, for MTBE is 99 %, while average percent recovery values for 1,1-dichloroethane, MeCl₂, vinyl chloride, and chloroform range from 73 % to 77 %; average percent recovery values for benzene, PCE, CDCE, and TCE range from 53 % to 63 %; and average percent recovery values for toluene, ethyl benzene, and o-xylene range from 32 % to 37 %.

X1.1.9.3 As shown in Table X1.7 for the 25-g En Core sampler, all of the VOCs of interest have average percent

recovery values greater than 90 % for storage of the spiked prairie soil samples at 4 ± 2°C for 48 h, for storage at -12 ± 2°C for seven days, for storage at -12 ± 2°C for 14 days, for storage at 4 ± 2°C for 48 h followed by storage at -12 ± 2°C for five days, and for storage at 4 ± 2°C for 48 h followed by storage at -12 ± 2°C for 12 days. The only exceptions are toluene at 88 % recovery for storage at 4 ± 2°C for 48 h, MeCl₂ ranging from 82 % to 89 % recovery for the last four storage conditions, and vinyl chloride at 88 % recovery for storage at -12 ± 2°C for 14 days. The mean of the 60 average percent recovery values listed in Table X1.7 for the analytes of interest for the five storage conditions discussed above is 96 % recovery with a standard deviation of 5 % and a percent relative standard deviation of 5 %. For storage at 4 ± 2°C for seven days, the VOCs of interest have average percent recovery values that are greater than 80 %, except for o-xylene, toluene, ethyl benzene, and MeCl₂, which have average percent recovery values ranging from 64 % to 73 %. For storage of the spiked prairie soil in the 25-g En Core sampler at 4 ± 2°C for 14 days, the average percent recovery for MTBE is 94 %. In addition, for this storage condition, average percent recovery values range from 83 % to 89 % for 1,1-dichloroethane, vinyl chloride, and chloroform; from 71 % to 75 % for PCE, benzene, MeCl₂, TCE, and CDCE; and from 54 % to 60 % for toluene, o-xylene, and ethyl benzene.

X1.1.9.4 As discussed in X1.1.9.1, in previous testing, lower average percent recovery values for the prairie soil were due to scattered particles compromising the seals of the En Core caps. The average percent recovery values for vinyl chloride from the spiked prairie soil samples in this study range from 76 % to 103 % for the 5-g sampler and 87 % to 105 % for the 25-g sampler for up to 14 days of storage (Table X1.6 and Table X1.7). These average percent recovery values show that the seals of the samplers in this study were not compromised. If volatilization losses occurred because of compromised seals, these values would be expected to be much lower due to the volatility of vinyl chloride. Biodegradation also does not seem to be an explanation for the lower average percent recovery values for the prairie soil samples stored for 7 and 14 days at 4 ± 2°C, because some of the compounds having lower average percent recovery values are chlorinated, and chlorinated compounds are resistant to biodegradation. In addition, the microbial activity of the river bank soil is slightly higher than that of the prairie soil (see X1.1.1), so if biodegradation is occurring, a similar trend would be expected for the river bank soil average percent recovery values. It appears that some sort of reaction between some of the analytes of interest (such as CDCE, benzene, TCE, toluene, PCE, ethyl benzene, and o-xylene) and the prairie soil may be occurring at 4 ± 2°C that is hindered by the lower freezing temperature. The prairie soil has undergone additional characterization; however, no information has been obtained to further explain the data.

X1.2 A second study was performed to evaluate the performance of the 5- and 25-g En Core samplers to store the mountain soil (see X1.1.1) used in the study described in X1.1 at temperatures of -7 ± 1°C and -21 ± 2°C. The 5-g devices used in this study were from lot number K113224, and the 25-g devices were from lot number K113206. The VOCs used in the

study are the same as those listed in X1.1.2, and the storage conditions used in the study are $-7 \pm 1^\circ\text{C}$ for 14 days, $-21 \pm 2^\circ\text{C}$ for 14 days, $4 \pm 2^\circ\text{C}$ for 48 h followed by storage for 5 days at $-7 \pm 1^\circ\text{C}$, and $4 \pm 2^\circ\text{C}$ for 48 h followed by storage for 5 days at $-21 \pm 2^\circ\text{C}$.

X1.2.1 This second study was performed as described in sections X1.1.3 through X1.1.5. As in the previous study, the samples were spiked to give an approximate concentration of 100 $\mu\text{g}/\text{Kg}$ of each analyte of interest in the samples, with the exception of benzene, toluene, ethyl benzene, and o-xylene. Because of their presence in the gasoline-saturated water, the concentrations of benzene were approximately 200 $\mu\text{g}/\text{Kg}$ to approximately 400 $\mu\text{g}/\text{Kg}$, and the concentrations of toluene were approximately 650 $\mu\text{g}/\text{Kg}$ to approximately 900 $\mu\text{g}/\text{Kg}$. Additional o-xylene and ethyl benzene were also added to the spiking solution by the gasoline-saturated water. This resulted in o-xylene and ethyl benzene concentrations in the spiked soil samples at approximately 300 $\mu\text{g}/\text{Kg}$ and approximately 200 $\mu\text{g}/\text{Kg}$, respectively.

X1.2.2 The temperatures in the freezers used to store the samples at -7 and -21°C were monitored using mini temperature data loggers.

X1.2.3 As for the data generated in the study described in X1.1, the data generated by this testing are specific to the experimental design of the study. They give information on the performance of the En Core samplers for storing soil samples collected from loose soil, spiked with a gasoline-saturated water solution containing selected analytes of interest, and then stored under specific storage conditions. The data generated by this testing are specific to the soil used in the study, the analytes of interest, the analyte concentrations, and the storage conditions that were evaluated. For other soil types, analytes, analyte concentrations, and storage conditions, these data may not apply.

X1.2.4 The average percent recoveries of the VOCs of interest from samples of the mountain soil stored in the 5-g En Core samplers are shown in Table X1.8; and the average

percent recoveries of the VOCs of interest from the samples of the mountain soil stored in the 25-g En Core samplers are shown in Table X1.9. In each of these tables, the percent relative standard deviation of the concentration values in the stored samples is given in parentheses next to the corresponding average percent recovery value. The percent relative standard deviation of the concentration values in the time-zero samples is given in a footnote to each of the tables.

X1.2.4.1 As shown in Table X1.8 for the 5-g sampler, all of the VOCs of interest have average percent recovery values that are greater than 90 % for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-7 \pm 1^\circ\text{C}$ for 5 days and for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-21 \pm 2^\circ\text{C}$ for 5 days. For storage at $-7 \pm 1^\circ\text{C}$ for 14 days and for storage at $-21 \pm 2^\circ\text{C}$ for 14 days, the average percent recovery values for all of the analytes of interest are greater than 80 %.

X1.2.4.2 As shown in Table X1.9 for the 25-g sampler, all of the VOCs of interest have average percent recovery values that are greater than 90 % for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-7 \pm 1^\circ\text{C}$ for 5 days, for storage at $-7 \pm 1^\circ\text{C}$ for 14 days, for storage at $4 \pm 2^\circ\text{C}$ for 48 h followed by storage at $-21 \pm 2^\circ\text{C}$ for 5 days, and for storage at $-21 \pm 2^\circ\text{C}$ for 14 days.

X1.3 A summary of the information obtained from the studies described in X1.1 and X1.2 is presented in Table X1.10. This table shows the storage conditions for which all or most of the analytes of interest have 90 % or greater or 80 % or greater average percent recovery for storage of the spiked soil in the 5-g and 25-g disposable En Core samplers. In addition, the data generated in the studies described in X1.1 and X1.2 for the mountain soil can be summarized as shown in Table X1.11. This table shows the storage conditions for the spiked mountain soil samples for which the average percent recovery values are 90 % or greater or 80 % or greater for the analytes of interest.

X2. PERFORMANCE OF THE 25-GRAM EN CORE SAMPLER TO STORE SOIL SAMPLES FOR VOC CHARACTERIZATION USING EPA METHOD 1311

X2.1 A study was conducted to evaluate the performance of the 25-g En Core sampler to store a soil spiked with EPA Method 1311 volatile analytes for subsequent characterization using EPA Method 1311. The En Core samplers used in this study were manufactured in July 2000. The 25-g devices that were used represent lot number K110187. The manufacturer can be contacted for information on this lot number.

X2.1.1 The soil used in the study was collected from a mountainous region in southeastern Wyoming. The soil contains 75 % sand, 13 % silt, 12 % clay, 4.3 % organic material, and approximately 12 % moisture, and has a dehydrogenase (microbial) activity of 11 mg total product formed (TPF)/g/24 h.

X2.1.2 In the study, data were generated for 22 of the 25 Method 1311 volatile analytes. Data could not be generated for methanol because it is the extraction solvent that was used for

VOC analysis (see X2.1.3). In addition, data could not be generated for isobutanol and n-butanol because of the difficulty in purging these compounds from the methanol-water mixture during analysis and because of the type of trap used for the purge-and-trap technique. The VOCs for which data were generated in the study are listed in Table X2.1.

X2.1.3 In this study, soil samples were collected in the 25-g En Core samplers from a large container of loose soil and then spiked with one of the spiking solutions described in X2.1.4. The spiking solution was injected into the middle of the soil plug in the sampler, and the sampler was immediately capped. After all samples were spiked and capped, five random samples for each spiking solution were extruded into methanol for analysis to give time-zero concentrations of the analytes of interest. The remaining samples were stored under the storage conditions shown in Table X2.2. As shown in this table,

TABLE X2.1 VOCs Used in the Study to Evaluate Performance of the 25-g En Core Sampler to Store Samples for EPA Method 1311

Acetone
Benzene
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroform
1,2-Dichloroethane
1,1-Dichloroethylene
Ethyl acetate
Ethyl benzene
Ethyl ether
Methylene chloride
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK)
Tetrachloroethylene (PCE)
Toluene
1,1,1-Trichloroethane
Trichloroethylene (TCE)
Trichlorofluoromethane
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
Vinyl chloride
Total Xylenes

freezing at $-12 \pm 2^\circ\text{C}$ was evaluated as a storage condition. A frozen sample would not be appropriate for extraction in the zero-headspace extractor as specified in Method 1311. However, if the option that is given in Method 1311 for total analysis of the sample is performed, freezing may be a means of sample preservation during storage (see 3.2). For each spiking solution, five samples were stored under each storage condition. Storage temperatures were monitored to make sure they were at the specified temperature. After the samples were held for the appropriate times, they were extruded into methanol for extraction and analysis. The methanol extracts of the samples were analyzed using EPA Methods 8260B and 5030B.

X2.1.4 A single spiking solution containing all 22 compounds listed in Table X2.1 could act as a preservative. Therefore, the compounds were divided into three spiking solutions containing a smaller number of analytes. The first spiking solution contained vinyl chloride, carbon disulfide, chlorobenzene, 1,2-dichloroethane, 1,1-dichloroethylene, PCE, carbon tetrachloride, and chloroform. The second spiking solution contained trichlorofluoromethane, Freon 113, 1,1,1-trichloroethane, ethyl benzene, TCE, total xylenes, ethyl ether, and methylene chloride. The third spiking solution contained acetone, ethyl acetate, MEK, and MIBK. Benzene and toluene were present in all three spiking solutions. The spiking solutions were prepared by injecting a methanol solution containing a mixture of the specific analytes into gasoline-saturated water. Benzene and toluene were not present in the methanol solution, but came totally from the gasoline used to prepare the gasoline-saturated water. Spiking the soil samples in the 25-g En Core devices with 0.5 mL of the first or second spiking solution gave an approximate concentration of 100 $\mu\text{g/Kg}$ of each analyte in the soil, except for benzene, toluene, and total xylenes. The spiked soil samples contained approximately 300 $\mu\text{g/Kg}$ of benzene and approximately 1,000 $\mu\text{g/Kg}$ of toluene. Additional xylene and ethyl benzene were added to the second spiking solution by the gasoline-saturated water. This resulted in xylene and ethyl benzene concentrations

in the spiked soil at approximately 500 $\mu\text{g/Kg}$ and approximately 100 $\mu\text{g/Kg}$, respectively. The third spiking solution was prepared as described above; however, because of the difficulty in purging acetone, ethyl acetate, MEK, and MIBK from the water-methanol mixture during analysis of the methanol extract of the soil, the spiking solution was prepared and the samples were spiked to give higher concentrations of these analytes in the soil. Their concentrations in the spiked soil were as follows: acetone at approximately 2000 $\mu\text{g/Kg}$, MEK at approximately 4000 $\mu\text{g/Kg}$, ethyl acetate at approximately 1000 $\mu\text{g/Kg}$, and MIBK at approximately 4000 $\mu\text{g/Kg}$.

X2.1.5 To evaluate the data, the mean concentrations of the analytes in the stored samples were compared to their mean concentrations in the time-zero samples by calculating average percent recovery. Before average percent recovery was calculated, the data sets were evaluated for outlier data points as described in Practice D 2777.

X2.1.6 The data generated by this testing are specific to the experimental design of the study. The data give information on the performance of the 25-g En Core sampler for storing soil samples collected from loose soil, spiked with a gasoline-saturated water solution containing EPA Method 1311 volatile organic analytes, and then stored under various storage conditions for 14 days. The data generated by this testing are also specific to the soil used in the study, the analytes used, the analyte concentrations, and the storage conditions that were evaluated. For other matrices and soil types, analytes, analyte concentrations, and storage conditions, these data may not apply.

X2.1.7 The average percent recoveries of Method 1311 volatile analytes from the spiked mountain soil samples stored in the 25-g disposable En Core samplers are shown in Table X2.3. In this table, the percent relative standard deviation of the concentration values in the stored samples is given in parentheses next to the corresponding average percent recovery value. The percent relative standard deviation of the concentration values in the time-zero samples is given in a footnote to the table.

X2.1.7.1 As shown in Table X2.3, carbon disulfide and ethyl acetate have very low recoveries from the stored samples for all three storage conditions. Based on the data for the other compounds listed in Table X2.3, it can be assumed that this is not due to loss of these compounds from the samples, but most likely due to a reaction with the soil matrix.

X2.1.7.2 Average percent recovery values for the compounds listed in Table X2.3, excluding carbon disulfide and ethyl acetate, range from 83 % to 103 % for storage at $4 \pm 2^\circ\text{C}$ for 14 days, except for 1,2-dichloroethane at 75 % recovery and 1,1-dichloroethylene at 71 % recovery; average percent recovery values for the compounds listed in Table X2.3, excluding carbon disulfide and ethyl acetate, for storage at $4 \pm 2^\circ\text{C}$ for 48 h and then 12 days at $-12 \pm 2^\circ\text{C}$ range from 85 % to 103 %; and average percent recovery values for the compounds listed in Table X2.3, excluding carbon disulfide and ethyl acetate, range from 91 % to 105 % for storage at $-12 \pm 2^\circ\text{C}$ for 14 days. Percent recovery values for benzene and toluene in the samples spiked with the first and second spiking solutions (see X2.1.4) are listed in Table X2.3 (benzene,

TABLE X2.2 Storage Conditions for Testing the 25-g En Core Sampler to Store Samples for EPA Method 1311

Storage Times/ Conditions	No Storage	-18 h at 4 ± 2°C in a cooler/ 12 Days at 4 ± 2°C in a refrigerator	14 days in a freezer at -12 ± 2°C	-18 h at 4 ± 2°C in a cooler/ 12 days at -12 ± 2°C in a freezer
Time-zero	5-samples	5 samples	5 samples	5 samples
14 days				
14 days				
14 days				

TABLE X2.3 Average Percent Recoveries of Method 1311 Volatile Analytes from Mountain Soil Samples Stored in 25-g Disposable En Core Samplers

Storage Conditions:	48 h at 4 ± 2°C in cooler/ 12 days at 4 ± 2°C in refrigerator	48 h at 4 ± 2°C in cooler/ 12 days at -12 ± 2°C in freezer	14 days in freezer at -12 ± 2°C
VOCs			
Acetone	101 ^A (8) ^B	98 (3)	99 (9)
Benzene	98 (3)	103 (3)	103 (5)
Benzene in duplicate sample	100 (2)	101 (0.5)	102 (4)
Carbon disulfide	8 (10)	29 (17)	55 (7)
Carbon tetrachloride	97 (2)	98 (4)	102 (5)
Chlorobenzene	96 (2)	99 (2)	97 (3)
Chloroform	94 (1)	102 (3)	100 (2)
1,2-Dichloroethane	75 (2)	99 (3)	100 (4)
1,1-Dichloroethylene	71 (13)	88 (4)	95 (6)
Ethyl acetate	< 27	< 27	< 27
Ethyl benzene	102 (2)	99 (2)	100 (3)
Ethyl ether	97 (6)	98 (1)	93 (4)
Methylene chloride	98 (5)	100 (2)	104 (8)
MEK	96 (9)	95 (4)	95 (8)
MIBK	103 (3)	99 (2)	99 (7)
PCE	98 (3)	99 (1)	103 (1)
Toluene	94 (2)	99 (4)	99 (3)
Toluene in duplicate sample	95 (2)	99 (2)	99 (3)
1,1,1-Trichloroethane	94 (5)	96 (2)	97 (2)
TCE	101 (2)	101 (1)	105 (5)
Trichlorofluoromethane	87 (5)	87 (3)	91 (7)
Freon 113	85 (7)	87 (5)	93 (3)
Vinyl chloride	83 (16)	85 (8)	92 (13)
Total Xylenes	100 (1)	100 (2)	101 (3)

^AAverage percent recovery is based on mean concentration values determined for five time-zero samples and five stored samples minus outlier data points.

^BThe value in parentheses is the percent relative standard deviation of the concentration values in the stored samples. The percent relative standard deviation of the concentration values in the time-zero samples ranged from 1 % to 6 % for all of the analytes, except for ethyl ether at 11 % and ethyl acetate at 37 %.

benzene in duplicate sample, toluene, toluene in duplicate sample). As shown, there is close agreement between average percent recovery values for the duplicates for the three storage conditions.

in the stored samples (values in parentheses) are less than 10 %, showing good precision of the performance of the En Core samplers to store the spiked soil samples.

X2.1.7.3 For most of the compounds listed in Table X2.3, percent relative standard deviations of the concentration values

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APPENDIX G

USEPA ENVIRONMENTAL RESPONSE TEAM: SOP 2050, OPERATION OF THE MD70 ASV POSI-TRACK/540B GEOPROBE



MODEL 5400 GEOPROBE™ OPERATION

SOP#: 2050
DATE: 03/27/96
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the collection of representative soil, soil-gas, and groundwater samples using a Model 5400 Geoprobe™ sampling device. Any deviations from these procedures should be documented in the site/field logbook and stated in project deliverables.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

The Geoprobe™ sampling device is used to collect soil, soil-gas and groundwater samples at specific depths below ground surface (BGS). The Geoprobe™ is hydraulically powered and is mounted in a customized four-wheel drive vehicle. The base of the sampling device is positioned on the ground over the sampling location and the vehicle is hydraulically raised on the base. As the weight of the vehicle is transferred to the probe, the probe is pushed into the ground. A built-in hammer mechanism allows the probe to be driven through dense materials. Maximum depth penetration under favorable circumstances is about 50 feet. Components of the Model 5400 Geoprobe™ are shown in Figures 1 through 6 (Appendix A).

Soil samples are collected with a specially-designed sample tube. The sample tube is pushed and/or vibrated to a specified depth (approximately one foot above the intended sample interval). The interior plug of the sample tube is removed by inserting small-diameter threaded rods. The sample tube is then driven an additional foot to collect the samples. The probe sections and sample tube are then withdrawn and the sample is extruded from the tube into sample jars.

Soil gas can be collected in two ways. One method

involves withdrawing a sample directly from the probe rods, after evacuating a sufficient volume of air from the probe rods. The other method involves collecting a sample through tubing attached by an adaptor to the bottom probe section. Correctly used, the latter method provides more reliable results.

Slotted lengths of probe can be used to collect groundwater samples if the probe rods can be driven to the water table. Groundwater samples are collected using either a peristaltic pump or a small bailer.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

Refer to specific ERT SOPs for procedures appropriate to the matrix, parameters and sampling objector.

Applicable ERT SOPs include:

ERT #2012, Soil Sampling

ERT #2007, Groundwater Well Sampling

ERT #2042, Soil Gas Sampling

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

A preliminary site survey should identify areas to be avoided with the truck. All underground utilities should be located and avoided during sampling. Begin sampling activities with an adequate fuel supply.

Decontamination of sampling tubes, probe rods, adaptors, non-expendable points and other equipment that contacts the soil is necessary to prevent cross-contamination of samples. During sampling, the bottom portion and outside of the sampling tubes can be contaminated with soil from other depth intervals.

Care must be taken to prevent soil which does not represent the sampled interval from being incorporated into the sample. Excess soil should be carefully wiped from the outside surface of the sampling tube and the bottom 3 inches of the sample should be discarded before extruding the sample into a sample jar.

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent upon the parameter(s) of interest. Guidelines for the containment, preservation, handling and storage of soil-gas samples are described in ERT SOP #2042, Soil-Gas Sampling.

Obtaining sufficient volume of soil for multiple analyses from one sample location may present a problem. The Geoprobe™ soil sampling system recovers a limited volume of soil and it is not possible to reenter the same hole and collect additional soil. When multiple analyses are to be performed on soil samples collected with the Geoprobe™, it is important that the relative importance of the analyses be identified. Identifying the order of importance will ensure that the limited sample volume will be used for the most crucial analyses.

5.0 EQUIPMENT/APPARATUS

Sampling with the Geoprobe™ involves use of the equipment listed below. Some of the equipment is used for all sample types, others are specific to soil (S), soil gas (SG), or groundwater (GW) as noted.

- C Geoprobe™ sampling device
- C Threaded probe rods (36", 24", and 12" lengths)
- C Drive Caps
- C Pull Caps
- C Rod Extractor
- C Expendable Point Holders
- C Expendable Drive Points
- C Solid Drive Points
- C Extension Rods
- C Extension Rod Couplers
- C Extension Rod Handle
- C Hammer Anvil
- C Hammer Latch
- C Hammer Latch Tool
- C Drill Steels
- C Carbide-Tipped Drill Bit

- C Mill-Slotted Well Point (GW)
- C Threaded Drive Point (GW)
- C Well Mini-Bailer (GW)
- C Tubing Bottom Check Valve (GW)
- C 3/8" O.D. Low Density Polyethylene Tubing (GW, SG)
- C Gas Sampling Adaptor and Cap (SG)
- C Teflon Tape
- C Neoprene "O" - Rings (SG)
- C Vacuum System (mounted in vehicle) (SG)
- C Piston Tip (S)
- C Piston Rod (S)
- C Piston Stop (S)
- C Sample Tube (11.5" in length) (S)
- C Vinyl Ends Caps (S)
- C Sample Extruder (S)
- C Extruder Pistons (Wooden Dowels) (S)
- C Wire Brush
- C Brush Adapters
- C Cleaning Brush (Bottle)

6.0 REAGENTS

Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURES

Portions of the following sections have been condensed from the Model 5400 Geoprobe™ Operations Manual(1). Refer to this manual for more detailed information concerning equipment specifications, general maintenance, tools, throttle control, clutch pump, GSK-58 Hammer, and troubleshooting. A copy of this manual will be maintained with the Geoprobe™ and on file in the Quality Assurance (QA) office.

7.1 Preparation

1. Determine extent of the sampling effort, sample matrices to be collected, and types and amounts of equipment and supplies required to complete the sampling effort.
2. Obtain and organize necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Perform a general site survey prior to site

entry in accordance with the site-specific Health and Safety Plan.

5. Use stakes or flagging to identify and mark all sampling locations. All sample locations should be cleared for utilities prior to sampling.

7.2 Setup of Geoprobe™

1. Back carrier vehicle to probing location.
2. Shift the vehicle to park and shut off ignition.
3. Set parking brake and place chocks under rear tires.
4. Attach exhaust hoses so exhaust blows downwind of the sampling location (this is particularly important during soil gas sampling).
5. Start engine using the remote ignition at the Geoprobe™ operator position.
6. Activate hydraulic system by turning on the Electrical Control Switch located on the Geoprobe™ electrical control panel (Figure 1, Appendix A). When positioning the probe, always use the SLOW speed. The SLOW speed switch is located on the hydraulic control panel (Figure 2, Appendix A).

Important: Check for clearance on vehicle roof before folding Geoprobe™ out of the carrier vehicle.

7. Laterally extend the Geoprobe™ from the vehicle as far as possible by pulling the EXTEND control lever toward the back of the vehicle while the Geoprobe™ is horizontal.
8. Using the FOOT control, lower the Derrick Slide so it is below cylinder (A) before folding the Geoprobe™ out of the carrier vehicle (Figure 3, Appendix A). This will ensure clearance at the roof of the vehicle.
9. Use the FOLD, FOOT, and EXTEND controls to place Geoprobe™ to the exact

probing location. Never begin probing in the fully extended position.

10. Using the FOLD control, adjust the long axis of the probe cylinder so that it is perpendicular (visually) to the ground surface.
11. Using the FOOT control, put the weight of the vehicle on the probe unit. Do not raise the rear of the vehicle more than six inches.

Important: Keep rear vehicle wheels on the ground surface when transferring the weight of the vehicle to the probe unit. Otherwise, vehicle may shift when probing begins.

12. When the probe axis is vertical and the weight of the vehicle is on the probe unit, probing is ready to begin.

7.3 Drilling Through Surface Pavement or Concrete

1. Position carrier vehicle to drilling location.
2. Fold unit out of carrier vehicle.
3. Deactivate hydraulics.
4. Insert carbide-tipped drill bit into hammer.
5. Activate HAMMER ROTATION control by turning knob counter-clockwise (Figure 4, Appendix A). This allows the drill bit to rotate when the HAMMER control is pressed.
6. Press down on HAMMER control to activate counterclockwise rotation.
7. Both the HAMMER control and the PROBE control must be used when drilling through the surface (Figure 4, Appendix A). Fully depress the HAMMER control, and incrementally lower the bit gradually into the pavement by periodically depressing the PROBE control.
8. When the surface has been penetrated, turn the HAMMER Control Valve knob

clockwise to deactivate hammer rotation and remove the drill bit from the HAMMER.

Important: Be sure to deactivate the rotary action before driving probe rods.

7.4 Probing

1. Position the carrier vehicle to the desired sampling location and set the vehicle parking brake.
2. Deploy Geoprobe™ Sampling Device.
3. Make sure the hydraulic system is turned off.
4. Lift up latch and insert hammer anvil into hammer - push latch back in (Figure 5, Appendix A).
5. Thread the drive cap onto the male end of the probe rod.
6. Thread an expendable point holder onto the other end of the first probe rod.
7. Slip an expendable drive point into point holder.
8. Position the leading probe rod with expendable drive point in the center of the derrick foot and directly below the hammer anvil.

Important: Positioning the first probe rod is critical in order to drive the probe rod vertically. Therefore, both the probe rod and the probe cylinder shaft must be in the vertical position (Figure 6, Appendix A).

9. To begin probing, activate the hydraulics and push the PROBE Control downward. When advancing the first probe rod, always use the SLOW speed. Many times the probe rods can be advanced using only the weight of the carrier vehicle. When this is the case, only the PROBE control is used.

Important: When advancing rods, always keep the probe rods parallel to the probe cylinder shaft (Figure 6, Appendix A).

This is done by making minor adjustments with the FOLD control. Failure to keep probe rods parallel to probe cylinder shaft may result in broken rods and increased difficulty in achieving desired sampling depth.

7.5 Probing - Percussion Hammer

The percussion hammer must be used in situations where the weight of the vehicle is not sufficient to advance the probe rods.

1. Make sure the Hammer Rotation Valve is closed.
2. Using the PROBE control to advance the rod, press down the HAMMER control to allow percussion to drive the rods (Figure 2, Appendix A).

Important: Always keep static weight on the probe rod or the rod will vibrate and chatter while you are hammering, causing rod threads to fracture and break.

3. Keep the hammer tight to the drive cap so the rod will not vibrate.
4. Periodically stop hammering and check if the probe rods can be advanced by pushing only.
5. Any time the downward progress of the probe rods is refused, the derrick foot may lift off of the ground surface. When this happens, reduce pressure on the PROBE control. Do not allow the foot to rise more than six inches off the ground or the vehicle's wheels may lift off the ground surface, causing the vehicle to shift (Figure 6, Appendix A).
6. As the derrick foot is raised off the ground surface, the probe cylinder may not be in a perpendicular position. If this happens, use the FOLD control to correct the probe cylinder position.

7.6 Probing - Adding Rods

1. Standard probe rods are three feet in length. If the desired depth is more than three feet,

another rod must be threaded onto the rod that has been driven into the ground. In order to ensure a vacuum-tight seal (soil-gas sampling), two wraps of teflon tape around the thread is recommended.

2. Using the PROBE control, raise the probe cylinder as high as possible.

Important: Always deactivate hydraulics when adding rods.

3. Deactivate hydraulics.
4. Unthread the drive cap from the probe rod that is in the ground.
5. Wrap teflon tape around the threads.
6. Thread the drive cap onto the male end of the next probe rod to be used.
7. After threading the drive cap onto the rod to be added, thread the rod onto the probe rod that has been driven into the ground. Make sure threads have been teflon taped. Continue probing.
8. Continue these steps until the desired sampling depth has been reached.

7.7 Probing/Pulling Rods

1. Once the probe rods have been driven to depth, they can also be pulled using the Geoprobe™ Machine.
2. Turn off the hydraulics.
3. Lift up latch and take the hammer anvil out of the hammer.
4. Replace the drive cap from the last probe rod driven with a pull cap.
5. Lift up the hammer latch.
6. Activate the hydraulics.
7. Hold down on the PROBE control, and move the probe cylinder down until the latch can be closed over the pull cap.

Important: If the latch will not close over the pull cap, adjust the derrick assembly by using the extend control. This will allow you to center the pull cap directly below the hammer latch.

8. Retract the probe rods by pulling up on the PROBE control.

Important: Do not raise the probe cylinder all the way when pulling probe rods or it will be impossible to detach a rod that has been pulled out. However, it is necessary to raise the probe cylinder far enough to allow the next probe section to be pulled.

9. After retracting the first probe rod, lower the probe cylinder only slightly to ease the pressure off of the hammer latch.
10. Attach a clamping device to the base of the rods where it meets the ground to prevent rods from falling back into the hole.
11. Raise the hammer latch.
12. Hold the PROBE control up and raise the probe cylinder as high as possible.
13. Unthread the pull cap from the retracted rod.
14. Unthread the retracted rod.
15. Thread the pull cap onto the next rod that is to be pulled.
16. Continue these steps until all the rods are retracted from the hole.
17. Decontaminate all portions of the equipment that have been in contact with the soil, soil gas and groundwater.

7.8 Soil-Gas Sampling Without Interior Tubing

1. Follow procedures outlined in Sections 7.1 through 7.6.
2. Remove hammer anvil from hammer.

3. Thread on pull cap to end of probe rod.
4. Retract rod approximately six inches. Retraction of the rod disengages expendable drive point and allows for soil vapor to enter rod.
5. Unthread pull cap and replace it with a gas sampling cap. Cap is furnished with barbed hose connector.

Important: Shut engine off before taking sample (exhaust fumes can cause faulty sample data).

6. Turn vacuum pump on and allow vacuum to build in tank.
7. Open line control valve. For each rod used, purge 300 liters of volume. Example: Three rods used = 900 liters = .900 on gauge.
8. After achieving sufficient purge volume, close valve and allow sample line pressure gauge to return to zero. This returns sample train to atmospheric pressure.
9. The vapor sample can now be taken.
 1. Pinch hose near gas sampling cap to prevent any outside vapors from entering the rods.
 2. Insert syringe needle into center of barbed hose connector and withdraw vapor sample.
10. To maintain suction at the sampling location, periodically drain the vacuum tank.
11. To remove rods, follow procedures outlined in Section 7.7.

7.9 Soil-Gas Sampling With Post-Run Tubing (PRT)

1. Follow procedures outlined in Sections 7.1 through 7.6.

2. Retract rod approximately six inches. Retraction of rod disengages expendable drive point and allows for soil vapor to enter rod.
3. Remove pull cap from the end of the probe rod.
4. Position the Geoprobe™ to allow room to work.
5. Secure PRT Tubing Adapter with "O" - Ring to selected tubing.
6. Insert the adapter end of the tubing down the inside diameter of the probe rods.
7. Feed the tubing down the hole until it hits bottom on the expendable point holder. Cut the tubing approximately two feet from the top probe rod.
8. Grasp excess tubing and apply some downward pressure while turning it in a counter-clockwise motion to engage the adapter threads with the expendable point holder.
9. Pull up lightly on the tubing to test engagement of threads.
10. Connect the outer end of the tubing to silicon tubing and vacuum hose (or other sampling apparatus).
11. Follow the appropriate sampling procedure (ERT SOP #2042, Soil Gas Sampling) to collect a soil-gas sample.
12. After collecting a sample, disconnect the tubing from the vacuum hose or sampling system.
13. Pull up firmly on the tubing until it releases from the adapter at the bottom of the hole.
14. Extract the probe rods from the ground and recover the expendable point holder with the attached adapter.

15. Inspect the "O"-ring at the base of the adapter to verify that proper sealing was achieved during sampling. The "O"-ring should be compressed.

Note: If the "O"-ring is not compressed, vapors from within the probe sections may have been collected rather than vapors from the intended sample interval.

7.10 Soil Sampling

1. Follow procedures outlined in Sections 7.1 through 7.6.
2. Assemble soil-sampling tube.
 1. Thread piston rod into piston tip.
 2. Insert piston tip into sample tube, seating piston tip into cutting edge of sample tube.
 3. Thread drive head into threaded end of sample tube.
 4. Thread piston stop pin into drive head. Stop pin should be tightened with wrench so that it exerts pressure against the piston rod.
3. Attach assembled sampler onto leading probe rod.
4. Drive the sampler with the attached probe rods to the top of the interval to be sampled.
5. Move probe unit back from the top of the probe rods to allow work room.
6. Remove drive cap and lower extension rods into inside diameter of probe rods using couplers to join rods together.
7. Attach extension rod handle to top extension rod.
8. Rotate extension rod handle clockwise until the leading extension rod is threaded into the piston stop in downhole.
9. Continue to rotate extension rod handle clockwise until reverse-threaded stop-pin has disengaged from the drive head.

10. Remove extension rods and attached stop-pin from the probe rods.
11. Replace drive cap onto top probe rod.
12. Mark the top probe rod with a marker or tape at the appropriate distance above the ground surface (dependent on sample tube length).
13. Drive probe rods and sampler the designated distance. Be careful not to overdrive the sampler which could compact the soil sample in the tube, making it difficult to extrude.

Important: Documentation of sample location should include both surface and subsurface identifiers. Example: Correct Method - Sample Location S-6, 12.0' - 13.0'. Incorrect Method - Sample Location S-6, 12.0'.

14. Retract probe rods from the hole and recover the sample tube. Inspect the sample tube to confirm that a sample was recovered.
 15. Disassemble sampler. Remove all parts.
 16. Position extruder rack on the foot of the Geoprobe™ derrick.
 17. Insert sample tube into extruder rack with the cutting end up.
 18. Insert hammer anvil into hammer.
 19. Position the extruder piston (wood dowel) and push sample out of the tube using the PROBE control on the Geoprobe™. Collect the sample as it is extruded in an appropriate sample container.
- Caution: use care when performing this task. Apply downward pressure gradually. Use of excessive force could result in injury to operator or damage to tools. Make sure proper diameter extruder piston is used.**
20. To remove rods follow procedures outlined in Section 7.7.

7.11 Groundwater Sampling

1. Follow Sections 7.1 through 7.6 with the following exception: the Mill-Slotted Well Rod with attached threaded drive point should be the first section probed into the ground. Multiple sections of mill-slotted well rods can be used to provide a greater vertical section into which groundwater can flow.
2. Probe to a depth at which groundwater is expected.
3. Remove Drive Cap and insert an electric water-level indicator to determine if water has entered the slotted sections of probe rod. Refer to ERT SOP #2043, Water Level Measurement, to determine water level.
4. If water is not detected in the probe rods, replace the drive cap and continue probing. Stop after each additional probe length and determine if groundwater has entered the slotted rods.
5. After the probe rods have been driven into the saturated zone, sufficient time should be allowed for the water level in the probe rods to stabilize.

Note: It will be difficult if not impossible to collect a groundwater sample in aquifer material small enough to pass through the slots (<0.02 inch diameter).

6. Groundwater samples may be collected with the 20-mL well Mini-Bailer or a pumping device. If samples are being collected for volatile organic analysis (VOA), the 20-mL Well Mini-Bailer should be used. If samples are being collected for a variety of analyses, VOA samples should be collected first using the bailer. Remaining samples can be collected by pumping water to the surface. Withdrawing water with the pump is more efficient than collecting water with the 20-mL well Mini-Bailer.

Important: Documentation of sample location should include both surface and subsurface identifiers. Example: Sample Location GW-6, 17'-21' bgs, water level in

probe rods is 17 feet bgs, and the leading section of probe rod is 21 feet bgs. The water sample is from this zone, not from 17 feet bgs or 21 feet bgs.

7. Remove rods following procedures outlined in Section 7.7.

8.0 CALCULATIONS

Calculating Vapor Purge Volume for Soil-Gas Sampling without Interior Tubing

Volume of Air to be Purged (Liters) = 300 x
Number of Rods in the Ground

Volume in Liters/1000 = Reading on
Vacuum Pump Instrument Gauge

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and the REAC site specific Health and Safety Plan. The following is a list of health and safety precautions which specifically apply to Geoprobe™ operation.

1. Always put vehicle in "park", set emergency the brake, and place chocks under the tires, before engaging remote ignition.

2. If vehicle is parked on a loose or soft surface, do not fully raise rear of vehicle with probe foot, as vehicle may fall or move.
3. Always extend the probe unit out from the vehicle and deploy the foot to clear vehicle roof line before folding the probe unit out.
4. Operators should wear OSHA approved steel-toed shoes and keep feet clear of probe foot.
5. Operator should wear ANSI approved hard hats.
6. Only one person should operate the probe machine and the assemble or disassemble probe rods and accessories.
7. Never place hands on top of a rod while it is under the machine.
8. Turn off the hydraulic system while changing rods, inserting the hammer anvil, or attaching accessories.
9. Operator must stand on the control side of the probe machine, clear of the probe foot and mast, while operating controls.
10. Wear safety glasses at all times during the operation of this machine.
11. Never continue to exert downward pressure on the probe rods when the probe foot has risen six inches off the ground.
12. Never exert enough downward pressure on a probe rod so as to lift the rear tires of the vehicle off the ground.
13. Always remove the hammer anvil or other tool from the machine before folding the machine to the horizontal position.
14. The vehicle catalytic converter is hot and may present a fire hazard when operating over dry grass or combustibles.
15. Geoprobe™ operators must wear ear protection. OSHA approved ear protection for sound levels exceeding 85 dba is recommended.
16. Locations of buried or underground utilities and services must be known before starting to drill or probe.
17. Shut down the hydraulic system and stop the vehicle engine before attempting to clean or service the equipment.
18. Exercise extreme caution when using extruder pistons (wooden dowels) to extrude soil from sample tubes. Soil in the sample tube may be compacted to the point that the extruder piston will break or shatter before it will push the sample out.
19. A dry chemical fire extinguisher (Type ABC) should be kept with the vehicle at all times.

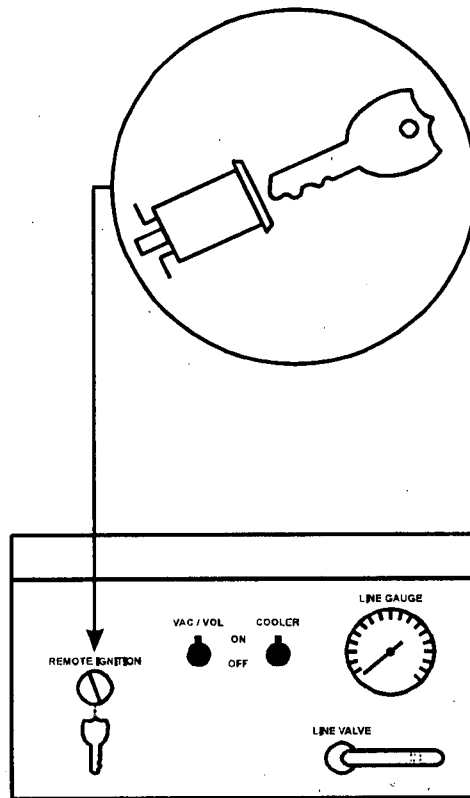
12.0 REFERENCES

1. Model 5400 Geoprobe™ Operations Manual. Geoprobe™ Systems, Salina, Kansas. July 27, 1990.
2. Geoprobe™ Systems - 1995-96 Tools and Equipment Catalog.

APPENDIX A

Figures

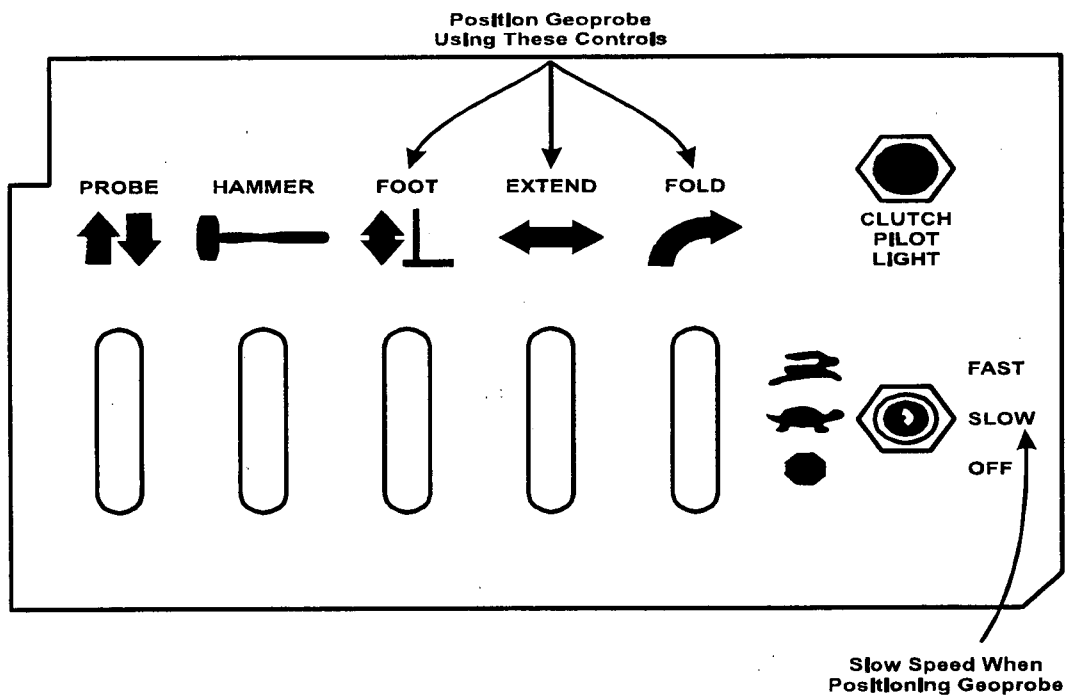
FIGURE 1. Electrical Control Panel



APPENDIX A (Cont'd)

Figures

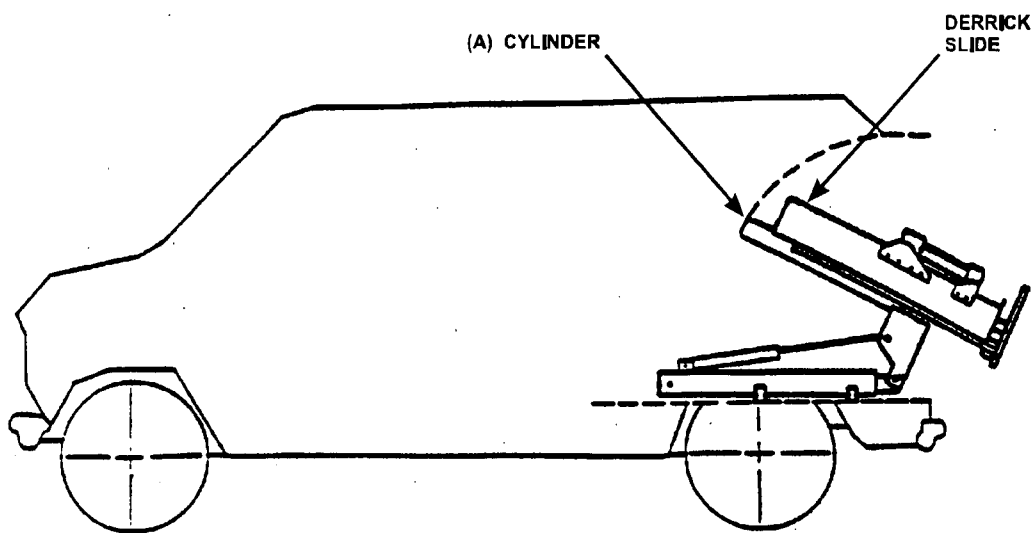
FIGURE 2. Hydraulic Control Panel



APPENDIX A (Cont'd)

Figures

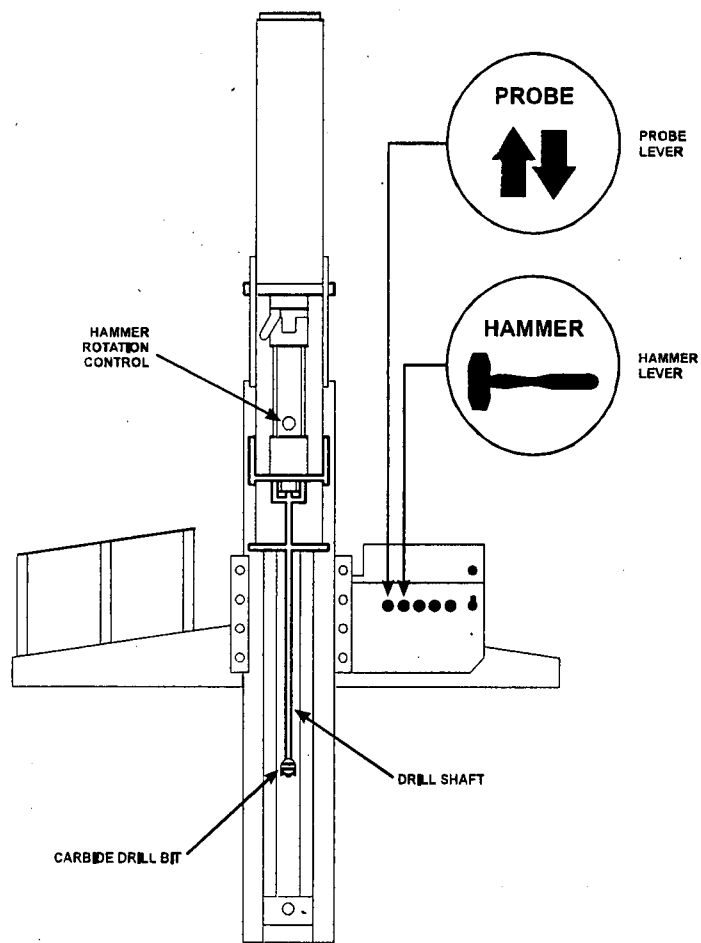
FIGURE 3. Deployment of Geoprobe™ from Sampling Vehicle



APPENDIX A (Cont'd)

Figures

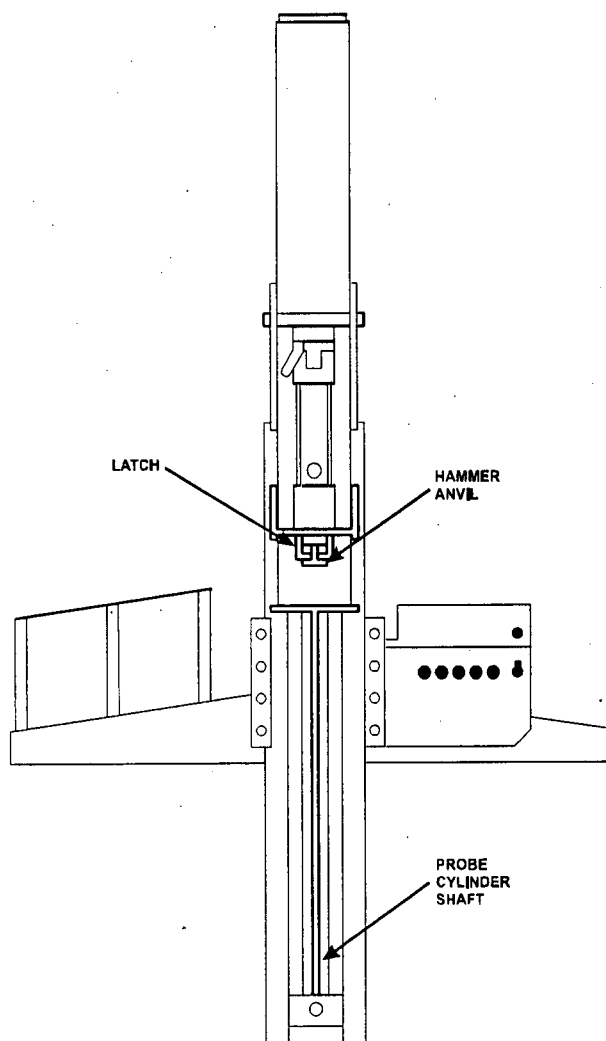
FIGURE 4. Geoprobe™ Setup for Drilling Through Concrete and Pavement



APPENDIX A (Cont'd)

Figures

FIGURE 5. Inserting Hammer Anvil



APPENDIX A (Cont'd)

Figures

FIGURE 6. Probe Cylinder Shaft and Probe Rod - Parallel and Vertical

